

REPORT ON GAS AND DUST EXPLOSION AT FEDERAL NO. 3
MINE, NEW ENGLAND FUEL AND TRANSPORTATION COMPANY,
EVERETTVILLE, W. VA., APRIL 30, 1927.

Introduction.

A gas and dust explosion occurred at 3:20 p.m. April 30, 1927 at the Federal No. 3 Mine of the New England Fuel and Transportation Company, Everettville, W. Va. Six men were killed in the tipple and 91 in the mine. Of the 91 men killed in the mine, 86 met instant death, 2 traveled a distance of about 500 feet before they were overcome by afterdamp and 3 attempted to barricade themselves in a pumproom but were overcome by afterdamp. Messages written by one of the 3 men in the pumproom on scraps of paper torn from cement bags indicate that they lived 3 hours or more. Five workmen in the tipple were seriously injured. Nine men were temporarily imprisoned in the South Main section of the mine. One of these made his way through the smoke to the outside and returned with a party of men wearing self-rescuers. The 8 who had barricaded themselves in No. 3 room 7 left off the south mains were supplied with self-rescuers, they then walked out of the mine. These men were rescued within about 2 hours after the explosion.

The explosion originated near the farthest working face in the mine when a storage battery locomotive ignited an accumulation of explosive gas. The entire mine, excepting the south mains, was involved. Propagation was due to coal dust and an atmosphere

more or less charged with methane for the first 4000 feet. Propagation throughout the balance of the workings was due to the presence of coal dust. Flame of the explosion extended beyond the tipple; there was evidence of heat 600 feet out by the pit mouth.

The mine was not systematically rock-dusted. About a year prior to the explosion the haulageroads were rock-dusted but no attempt was made to maintain the incombustible content of the dust at any definite standard. There were a number of local depressions in the coal bed and as a general rule the mine was wet at such places but water was not used on the cutting bars of coal cutting machines, or for sprinkling the roadways to allay the dust.

Notice of the explosion and request for aid was received at the Pittsburgh, Pa., office of the Bureau of Mines at about 4:40 p.m. eastern standard time. G. S. McCaa and G. W. Grove of the Bureau of Mines, and J. T. Ryan and George Deike of the Mine Safety Appliances Company arrived at Everettville at 11 p.m. H. C. Howarth and H. Burdelsky of the Bureau arrived 3 hours later with a supply of gas masks and gas mask canisters. Car Holmes arrived at about 3 a.m. May 1. Following is a complete list of Bureau of Mines men present during the recovery work:- Messrs. D. Harrington, McCaa, Howarth, Grove, W. H. Forbes, Kintz, Burdelsky, Currie, London, G. H. Miller and Wallace. A complete list of West Virginia state officials, officials of the coal company, the Mine Safety Appliances Company and the 21 oxygen breathing apparatus teams with men in charge of same who were present

during the recovery work is given in Appendix I. Appendix VI is a map of the mine showing the various steps of advancement in the recovery work, also this map shows the approximate locations where bodies were found. Appendix XIII gives the locations where bodies were found and the names of the men killed. The tabulation of air samples in Appendix VIII shows the condition of the mine atmosphere throughout the recovery work. The 21 apparatus crews built approximately 80 stoppings while wearing apparatus. All of the apparatus men were examined frequently by doctors who were on duty constantly during the recovery work. Appendix XII is a copy of the report of the medical and surgical cases relative to the recovery work following the explosion. The medical report shows that a number of men were poisoned by carbon monoxide and the analyses of samples of afterdamp show that there was as much as 4.4 per CO in the afterdamp.

Ventilation was reestablished and all afterdamp removed on May 12, or 12 days after the explosion occurred. The last bodies were recovered on May 24, or 24 days after the explosion. All the water was not pumped out until June 6. The investigation for the Bureau of Mines was completed on June 7 and the coroner's inquest was held in the Court House at Morgantown, W. Va. June 8. The data contained in this report was obtained by George S. McCaa and H. C. Howarth, District Engineer and Coal Mine Superintendent respectively of the Bureau of Mines.

Location of Mine.

Federal No. 3 Mine is located at Everettville, Monongalia County, West Virginia, about one mile from Lowsville station on the Monongahela Railroad. The Monongahela Railroad is the only railroad having connection with this mine. The post office at the mine is Everettville, W. Va.

The principal officers of the company are:-

E. M. Richards, President, 111 Devonshire St., Boston,
Mass.

G. A. G. Wood, Vice Pres., 111 Devonshire St., Boston,
Mass.

J. W. Devison, Gen. Supt., Grant Town, W. Va.

J. M. McKenna, Asst. Gen. Supt., Grant Town, W. Va.

J. A. McKay, Supt., Everettville, W. Va.

John Spiker, Mine Foreman, Everettville, W. Va.

Total number of employees 340. Inside 260, outside 80. Average daily output 2000 tons.

Surface openings.

The mine was opened in 1918. Surface openings are drifts. The 3 principal openings are near the tipple. One of these is the fan inlet, one for delivering loaded cars to the tipple and the third for the return of empty cars to the mine. There are several additional drift openings in the outcrop which are used for drainage and return air outlets. In addition to the drift openings there are cracks to the surface and into the

mine operating the overlying Sewickley bed.

Description of coal bed.

The mine is operating the Pittsburgh coal bed which, at this mine, has an average thickness of 90 inches and dips about 3 per cent to the north. The Pittsburgh bed is about 80 feet below the Sewickley bed. The coal is a high volatile bituminous coal and is very friable. It is used principally as a gas and coking coal. There are 2 slate partings 3 to 4 inches apart about 30 inches from the bottom. Immediately overlying the coal there is a heavy drawslate which falls readily when unsupported. In order to hold this drawslate in place about a foot of top coal is left to support it.

A composite analysis of the coal is as follows:- Moisture, 1.3 per cent, volatile matter 38.0 per cent, fixed carbon 52.3 per cent, ash, 7.9 per cent. Three face samples were collected by Messrs. Currie and Miller on May 18 and 19, 1927. These samples were analyzed at the Pittsburgh laboratory of the Bureau of Mines. For detailed analysis reports by Mr. H. M. Cooper, see Appendix II. Comparison with a typical analysis of coal from the Bureau's Experimental Mine, also given in the above appendix, shows that the coal from Federal No. 3 mine has a slightly higher ratio of volatile combustible to total combustible matter and is slightly higher in fixed carbon and ash. The slight difference in composition is not sufficient to make any appreciable difference in the explosibility of the coal from these two mines.

METHOD OF MINING

A map of the mine showing the general plan of the workings will be found in Appendix III. A panel block system of mining is used in which all rooms and entries are 12 feet wide. The coal is undercut by enclosed non-permissible coal cutting machines after which it is shot down and loaded by the miners. Pillars are extracted and a high percentage of recovery is attained. An entry driving machine in the experimental stage was in use in one section of the mine. This machine loads trips of 5 or 6 cars and delivers them at the mouth of the entry where they are picked up by the main haulage motors. The motors on this loading machine are of the non-permissible type. Roof conditions are good and very little timbering is required in any part of the mine except where pillars are being extracted.

Ventilation and gases.

The workings to the left of the south mains were ventilated principally by air currents induced by natural means. The main part of the mine was ventilated by a non-reversible Robinson disc fan forcing about 90,000 cubic feet of air a minute into the mine. Double automatic doors on the main haulage road near the mouth of the mine permitted air locking empty and loaded trips into and out of the main intake airway. There were three main intake intake airways including the main haulage road, the traveling road and an entry between these which was used as a pipe and

propagation when there is 2 per cent of methane in the air. If there is no methane in the mine air, 60 per cent incombustible matter in the dust will prevent propagation. See U. S. Bureau of Mines Bulletin, #167 pages 208 and 209 for tests with dust approximately the same size as dust in Federal No. 3 mine.

For explosibility testing of different sized Pittsburgh dusts see pages 187 to 217 inclusive of the same bulletin.

wire way, also as space for side tracks. The overcasts observed were of good masonry. Practically all of the stoppings, except those along the main dip headings, were built of wood and canvas. Most of the doors were of the automatic type.

The main ventilating current was divided at No. 1 and No. 2 room on 9 southwest. One split ventilated all the workings on the south west side of the main dips from 2 southwest to 8 southwest inclusive. Small splits of fresh air were added to this split at No. 2 southwest and No. 4 southwest. These small splits were made at these points so that hauling by trolley locomotives would be ^{on} intake air. The other split of the main ventilating current ventilated 9, 10, 11 and 12 southwest, the main dips and all the workings on the northeast side of the main headings. This split was augmented by a split of fresh air at 7 north east which was intended to serve as a fresh air current to ventilate the haulage-road in 7 northeast and the pump room at the head of 7 northeast. This description shows that there were but 2 splits or ventilation districts in that part of the mine involved in the explosion. See map Appendix III showing ventilation before the explosion.

Only one fireboss was employed to make an examination of the mine before the men on the dayshift entered. The section of the mine examined by this fireboss consisted of the greater portion of the last of the two ventilation districts described above. This part of the mine was rated as gassy by the State De-

partment of Mines. On May 20, 1927 methane was being liberated at the rate of 237,888 cubic feet in 24 hours. See samples 45690 to 45693 inclusive in table of air samples, Appendix IV. In this same table samples 45683-4 show that the workings in the shaft headings where the explosion originated were liberating methane at the rate of 82,130 cubic feet in 24 hours, or enough gas every hour to fill a 950-ft. length of single entry with an explosive mixture of gas and air.

Haulage.

The track gauge is 42 inches. The track on the main haulage road is laid with 60 pound per yard steel rails, room entries 30 pound and rooms 20 pound steel rails. Width of clearance between cars and ribs is 2 to 3 feet in most parts of the mine. Wooden mine cars of the lifting end gate type having a capacity of 3 tons each are used. Cars are loaded with a top-ping up to 12 inches. In the shaft headings, so called because they were being driven towards a proposed air shaft in the northwest section of the mine, non-permissible storage battery locomotives were used for gathering. In 8 and 9 northeast the loading machine delivered the loaded cars to the mouth of the entry and 26 horses gathered the coal in other parts of the mine. Trolley type locomotives were used for secondary and main haulage. All of the hauling in the shaft headings was in return air or air more or less charged with methane from workings in the main dips.

Lighting.

The mine is worked exclusively with permissible electric

cap lamps; even the horses are provided with lamps of this type. In addition to the electric cap lamps, each machine crew is provided with a magnetically-locked flame safety lamp. The foreman, assistant foreman, and fireboss, and face bosses use key-locked non-permissible flame safety lamps. Several of the flame safety lamps were examined in the mine during the investigation and a number, possibly 5 or 6, were found not locked. The locking device or screw was missing from a lamp picked up in No. 4 S. W. Fixed incandescent electric lights are installed at pumps, doors and the principal switches along the haulage roads.

Machinery underground is all of the non-permissible type. The electric wiring, where it had not been torn down by the explosion, was well installed. Some of the power lines were in air currents returning from workings which liberated methane, notably the shaft headings. The power wires also extended beyond break-throughs that were not closed with permanent wood or masonry stoppings. The following is a more or less complete list of the underground machinery:-
Mine cars 380, storage battery locomotives 3, trolley type locomotives 6, pumps 9, two of which delivered water to the surface; coal cutting machines, 4 Goodman Universal closed type (non-permissible) 4 Goodman shortwall and 1 Oldroyd; also 2 loading machines which were more or less in the experimental stage of development.

Explosives.

Monobel permissible explosives were used exclusively,

size of cartridges 1-1/4 by 8 inches. Diameter of hole 2 inches. Depth of hole 5-1/2 to 6 feet. The miners charged and fired shots at any time during the shift. The holes were stemmed with clay and fired electrically. Some of the material for stemming was hauled into the mine and some was dug from the fire clay bottom. In a number of places where cuts of coal had been shot down, the distance that coal was scattered and the fineness of the coal indicated that the shot holes had been overcharged.

Drainage.

Owing to numerous local depressions or dips in the coal bed, there are many places in the mine that are naturally wet but the high places between these low spots are dry and dusty. All of the area south of No. 1 southwest drainage heading is drained by ditches to the outside. All the water in the area lying between No. 1 southwest drainage heading and No. 7 northeast is carried by ditches to the pumping station in 7 northeast. The water in the area beyond 7 northeast is pumped into 7 northeast from which point it is delivered to the surface by two centrifugal pumps at the rate of about 500,000 gallons per day.

Dust.

After the explosion there was practically no dust on the reef, ribs or timbers except coked dust deposited by the explosion. There were large quantities of dust on the floor in all dry parts of the mine except where it was swept away by

the force of the explosion. The fineness of this dust was about the same as the average mine dust, of this dust passing through a 20 mesh sieve about 20 per cent would pass through a 200 mesh sieve. There was little inert matter in the dust samples, some of which had only a few per cent more ash than face samples of the coal. Analysis reports for face samples will be found in Appendix II. Tabulation and discussion of the dust samples will be found in Appendix V.

Water to ~~lay~~ way the dust was not used in any ~~term~~.

Rock dust.

About a year prior to the explosion the haulageroads were rock-dusted as far as the trolley extended. No attempt was made to maintain the incombustible matter in the mine dust at any definite standard and the dusting was not extended as the entries and rooms advanced. There were no rock-dust barriers in any part of the mine.

The mine conditions immediately prior to the explosion were ^{fine} normal. The mine was working full but many of the men had quit for the day on account of it being payday and Saturday. The fan was operating normally but workmen were engaged making repairs on the automatic doors on the main haulageroad near the mouth of the mine. The firebosses report for the day did not show any unusual conditions nor unusual accumulations of gas.

Previous explosions.

Prior to this time this mine never had an explosion. In the early part of 1926 two men were seriously burned when gas was ignited at the face of one of the shaft headings. On this occasion the gas ignited by the short circuiting of the cable on an electric drill which was drilling shot holes in the coal.

Property damage was extensive. The super-structure or housing of the tipple was ~~badly~~ somewhat damaged. The south main section of the mine was not damaged and there were no large falls in any part of the mine. All the stoppings and doors and 3 overcasts in the dip section were blown out. Long stretches of trolley and power wires were torn down and 100 or more empty mine cars were badly damaged. There was very little damage done to loaded mine cars. As a result of the explosion the mine probably will be idle 1 to 2 months, *for repairs.*

Maps.

Appendix III is a map of the mine showing the general plan of working, the direction of ventilating currents before the explosion, the points at which dust and air samples were taken and the direction of forces.

Appendix VI is a plan of the mine prepared by Mr. T. A. King, engineer, New England Fuel and Transportation Company, showing the location of bodies and the various steps in re-establishing ventilation. Also the location of a fire area

sealed about a year prior to the explosion, the place where fire was found after the explosion and the points where men were barricaded and where barricades were attempted.

Forces.

The explosion although extensive in scope should be classed as moderately violent. About 100 empty mine cars were badly damaged in various parts of the mine and but very few of the loaded cars showed evidence of force, except that the topping was blown off. The direction of force in different parts of the mine is indicated on the map in Appendix III. Following the path of the explosion the direction of force, and violence was noted as follows:-

The wooden battery covers on the battery locomotive were carried inby and to the east side of the locomotive at the last cutthrough in the aircourse of the shaft headings and the line brattice extending from the last cutthrough toward the face of the aircourse indicated that the force was inby. The position of the line brattice in the shaft heading at the last cutthrough indicated that the force of the explosion was through the cutthrough from the aircourse. An empty car on the shaft heading just inby the second cutthrough from the face was lifted off the track by the force of the explosion and moved outby 2 or 3 feet and a miner's cap was wedged between the end gate roller bar of this car and the power

wires which were torn from the insulators. The body of the miner who worked at the face of the aircourse, and who apparently was in the vicinity of this empty car when the explosion occurred, was rolled out by the force of the explosion. Practically all the stoppings between the shaft heading and the shaft heading aircourse were blown toward the east or shaft heading. The large quantities of brattice cloth and the small amount of wood present in these cutthroughs indicated that these stoppings were built mostly of brattice cloth. At a point on the shaft heading aircourse just outby the left pick-up a small gathering pump was blown outby and badly damaged. In No. 1 east off the shaft heading the last cut of coal making an opening into the 3rd cutthrough from 1 east aircourse was shot down and partly loaded out when the mine foreman made his morning visit, the remainder of this cut of coal was blown inby and against the opposite rib of the cutthrough by the explosion. A loaded mine car in the mouth of No. 1 east was lifted off the track by the force traveling outby on the shaft heading. A trip of 5 empty mine cars on the outer end of the side track on the shaft heading, about 1000 feet from the mains, were all badly damaged by force traveling outby. A pump in a cutthrough between the shaft heading and the shaft heading aircourse about 650 feet from the main dip headings was blown toward the aircourse and badly damaged. An overcast at the mouth of the shaft heading which had just been complet-

ed and would have been put into service the day following the explosion had the top blown out, part inby toward the face of the main dips and part outby toward the pit mouth. The branch of the explosion traveling toward the face of the dip headings had sufficient force to bend the end gates inby on five empty cars that were standing on No. 5 heading 250 feet from the face, also the end gates of 3 empty cars on No. 2 heading about 200 feet from the face. An empty car about 50 feet from the face of No. 2 dip heading had both ends bent outby. (Note:- During the recovery the dip headings were designated Nos. 1, 2, 3, 4, 5 and 6 consecutively from southwest to northwest. The same designation will be continued throughout this report.) In 11 S.W. and 12 S.W. the mine track was lifted but there was no definitely defined direction of force. In 13 S.W., which are short entries just turned off the mains, deposits of light débris indicated that force was about equal both inby and outby. In 10 S.W. which is on the opposite side of the mains and just outby the shaft headings there was considerable violence. There was evidence of force in all directions. In the first entry of No. 10 S.W. the track was torn up between No. 1 and No. 2 room the direction of force being inby and 7 empty cars at the mouth of the entry had end gates bent outby. An empty at the first cutthrough in No. 1 room was thrown off the track and badly broken, the direction of force being inby in the room. In No. 2 room a half loaded car was off the track 10 feet from the face. In middle entry of 10 S.W. an empty car was blown

to the face and a car and dinner buckets at the first cutthrough from the face were blown outby. In the 3rd or right hand entry of 10 S.W. all the evidence of force was outby and at the intersection of this entry with No. 1 dip, light débris indicated force toward the face of the dips. The butt shot at the face of the 3rd entry of 10 S.W., had been shot down recently but no coal had been loaded out after the shot was fired. The coal was scattered as though the hole had been overcharged and the wooden tamping stick was on top of the scattered coal along the left rib about 16 feet from the face. The body of the miner was found within 5 feet of the face and his right arm had been blown off at the elbow.

At the mouth of No. 10 room in 9 S.E. an empty car was lifted off the track and the end gates were bent inby. In 9 S.W., 8 S.W. and 7 S.W. the doors were blown inby and the stoppings between entries were blown both ways. Deposits of light debris at the corners of cutthroughs indicated that the general path of explosion in these entries was through the rooms from 9 to 8 and 7 S.W. At the entrance to 9 N.E. the transfer part of the experimental loading machine was badly twisted by force traveling inby. The explosion traveled from 9 N.E. through No. 1 and No. 2 rooms to 8 N.E. The evidence of force in these two entries was deposits of light débris, the blowing down of stoppings and the twisting of the loading machine mentioned above. A trip of 19 empty cars in 8 N.E. chute extending across Nos. 6, 5 and 4 main

dips were badly damaged by force traveling outby on the mains. In the No. 4 dip entry or the traveling road 3 cars were smashed together completely blocking the entry. In No. 5 entry an empty car was blown outby a distance of 180 feet and the end gate 45 feet beyond it. In No. 6 entry an empty car was blown outby a distance of 120 feet and the end gate 30 feet beyond it. Both these entries were trackless and there appears to have been more violence at this point than any other place in the mine.

In 6 S.W., 5 S.W. and 4 S.W. the explosion traveled inby from the main dips and continued through the open rooms from 7 S.W. to 6 S.W., from 6 S.W. to 5 S.W. and from 5 S.W. to 4 S.W. The violence in these entries was manifested mostly in the destruction of stoppings and the deposit of light debris at the corners of cutthroughs. This branch of the explosion continued through the open rooms from 4 S.W. across 3 S.W. to 2 S.W. but with increasing violence. The roof and ribs were scoured smooth and the floor was swept clean in rooms 15 and 16 off 3 S.W. for a distance of 100 feet or more at the 2 S.W. end. A trip of 17 empty cars which had been placed in the mouth of 16 room off 3 S.W. was subjected to considerable violence. The first 3 cars were badly twisted and the ends were bent toward 2 S.W. The last nine cars were beyond the end of the track toward 2 S.W. The first of these 9 cars was

badly damaged by force traveling from 3 S.W. to 2 S.W. Three empty cars in the middle entry in 2 S.W. just inby the chute to No. 4 left butt off 2 S.W. were reduced to a shapeless mass. These cars were opposite the cutthrough from the middle entry of 2 S.W. to the right aircourse between rooms 15 and 16 off 3 S.W. In 2 S.W. haulageroad there was no evidence of force whatever for a distance of 250 feet on each side of No. 2 left butt. In this zone the roof and ribs were still white with rock dust. The doors at the mouth of each of the southeast headings were blown inby by the branch of the explosion that traveled out the main dips, and the overcast at the mouth of 2 S.W. and one across the main haulageroad just inby 4 S.S. were demolished by forces from the underside.

Between 1 S.W. and 2 S.W. on the main haulageroad several timber cribs built of mine ties were blown outby. The automatic doors on the main haulageroad between the south mains and No. 1 S.W. were blown outby. Thirty-three men and 3 horses were killed on the main dips between the south mains and the shaft headings. Many of these bodies showed evidence of great violence, especially the bodies found on the main haulageroad between 4 S.W. and 5 S.W.

In 7 N.E. the explosion developed greatest violence along the haulageroad, blowing stoppings into the aircourse. A man and a horse were killed by violence at the mouth of No. 5 right off 7 N.E. and a loaded car was lifted off the track in

No. 3 right chute. This point was about 200 feet beyond the last evidence of flame in 7 N.E. At the entrance to all the N.E. entries outby 7 N.E. the stoppings and doors were blown into the entries by force from the explosion traveling out the mains. The branch of the explosion which traveled into 7 N.E. was much less violent than the branch that traveled up the S.W. side of the mains.

In the south mains inby the point where the main dips branch off, the top was lifted out of an overcast and the doors at the entrance to 2 left butt were blown out. At 3 and 4 left butts the doors were simply blown open. Occupants of a house near the point where No. 5 left off the south mains broke through to the surface stated that tin cans and other such articles that had been thrown into the hole were blown out by the explosion, creating considerable noise.

Debris was blown out of the mouth of the mine and across the valley a distance of about 600 feet. A number of empty cars were blown off the tipple, and part of superstructure of the tipple was blown away. A 5 inch by 6 inch mine tie was blown through the end of a car which was being dumped in the tipple at the time of the explosion. Extent of damage at the tipple and views of the mouth of the mine are shown in Appendix VII.

Evidence of heat and flame.

The flame of the explosion extended through about 90 per cent of the workings of the main dips and out of the mouth

of the mine not less than 250 feet. There were heavy masses of coke in the extreme outer end of the tipple and the wood-work of the tipple was on fire in a dozen or more places.

There was no evidence of flame in the south mains beyond No. 4 left butt except that the dust samples collected at No. 4 left butt carried a trace of coked dust particles. On the haulageroad at this point there was 75 per cent incombustible matter (moisture plus ash) in the road dust. The average incombustible for all the samples collected at this point was about 50 per cent. This high incombustible content and the relief of pressure at the mouth of the mine was sufficient to prevent propagation in the south mains.

In No. 2 S.W. the only evidence of flame or heat was the trace of coked dust found in the dust samples. The bodies found in this entry were not burned. The body found at the chute to No. 2 left was face down and had the appearance of having been overcome by afterdamp, the body found just cutby No. 3 left may have been overcome by afterdamp but the body found about half way between No. 3 left and No. 4 left had been rolled considerably by the explosion. No. 2 S.W. is flanked on the left by a worked out area extending the full length of the entry. This large worked out area and the small worked out area on No. 3 S.W. provided increased volume of openings sufficient to materially aid in preventing the spread of flame into all parts of 2 S.W.

The flame of the explosion did not penetrate all the workings in the section on the northeast side of the main dips between 3 N.E. and 7 N.E. Coked dust was found on both inby and outby exposures on 7 N.E. haulageroad about half way between 2 right butt and 3 right butt but there was no evidence of flame inby this point. A small fire consisting of a heap of smouldering dust and coke was found on the floor against the rib opposite the second right hand place off No. 1 right off 7 N.E. This smouldering mass, was about 10 inches deep, extended out from the rib a distance of 10 inches and parallel with the rib about 30 inches. This smouldering fire was found approximately 175 hours after the explosion occurred. The rib above and to the right and left of the fire was plastered with coked dust which had been thrown out of the room directly opposite the fire. There were heavy deposits of bright silvery coked dust on the roof and ribs in the room opposite the fire and the adjoining room. Only one of the 16 bodies found in this section showed unmistakable evidence of force. There was no conclusive evidence that any of the other 15 had been burned. Six of the 15 appear to have wandered distances of 250 feet to 500 feet after the explosion and 3 men attempted to build barricades near the pump room at the head of 7 N.E. drainage headings. (See map of mine Appendix VI for location of barricades). Their attempt to complete the barricades was unsuccessful principally because of lack of material to work with. Messages written to his wife by one of these

men indicated that they were still alive but growing weaker at 6:20 p.m. or 3 hours after the explosion.

The flame of the explosion penetrated every part of the mine inby and including 3 S.W. on the southwest side of the main dips and inby and including 8 N.E. on the northeast side. All of the bodies found in this section were badly burned and coked dust was plastered on ~~all~~ ^{the} exposures in 90 per cent of the dead ends. At the face of the entries 9 S.W. and 10 S.W. and 8 E.E. and 9 N.E. there were deposits of coked dust on the floor an inch or more in thickness. In No. 12 room off 3 S.W. in the cutthrough nearest the inby end of the rib there were deposits of coked dust 2 to 3 inches thick. It was the opinion of some of the state mine inspectors and others of the men engaged in the recovery work that some of this coked dust may have been hot enough to start fires had there been a plentiful supply of oxygen at any time immediately following the explosion.

Samples.

Three face samples of coal, 31 samples of mine air, 21 samples of road dust and 15 samples of rib and roof dust were taken. The face samples are tabulated and discussed in Appendix II, the air samples in Appendix IV, and the dust samples in Appendix V. Appendix VIII is a complete tabulation giving analyses of the 98 samples of afterdamp taken in connection with the rescue and recovery work.

State Inspectors' conclusions.

On the witness stand at the coroner's inquest 2 or more of the inspectors expressed the opinion that the explosion originated at or near the storage battery locomotive near the face of the left air course in the shaft headings by the ignition of an accumulation of gas, also that propagation was due to the presence of coal dust notwithstanding the fact that there were wet places in the path of the explosion. Mr. James McKenna, Assistant General Superintendent, stated that the explosion may have originated in No. 10 S. W. but gave no evidence in support of his conclusion.

Summary of evidence as to cause, origin and propagation.

A study of the direction of forces shows that the explosion originated near the face of the shaft headings and spread into the other workings as indicated by arrows on the mine map in Appendix III. The most likely sources of ignition within 100 feet of the face of these entries were the power wires, three safety lamps in the hands of the workmen and a storage battery locomotive. There was no evidence to indicate that there had been a short circuit on the power wires to cause ignition and an examination of the safety lamps showed that they were not likely to have been the cause of ignition. The section foreman's safety lamp, which was locked, and a safety lamp picked up in No. 4 S. W. were tested in the lamp gallery at the Pittsburgh station of the Bureau for external ignition of explosive gas. These lamps were subjected to several tests in each of three series but no ignitions were

obtained. A report giving the details of these tests is given in Appendix IX.

A careful study of the probable activities in the vicinity of the last cut-through in the shaft headings and the storage battery locomotive found opposite the outby corner of the cut-through leads to the conclusion that ignition of gas was caused by sparking or arcing at either the controller on the inby end or the commutator on the outby end of the locomotive - the most likely point of ignition being the commutator on the outby end of the locomotive, although there were several other places where electric sparks may have been made by loose connections or abraded insulation. A special examination of the locomotive in the mine before it was disturbed was made by H. B. Freeman, of the electrical section, Pittsburgh station of the Bureau. A copy of his report is attached as Appendix X.

A sketch, Appendix XI, shows the position of the locomotive and the bodies found near the face of the shaft headings. It is believed that when the explosion occurred, the locomotive was advancing toward the face of the aircourse to pull out a loaded car and was stalled in the position indicated. (The locomotive was operated with the cab or rear end toward the face.) The stalling of the locomotive was possibly due to a wedge-shaped split prop lying across the left hand rail under the left rear wheel, and to one of the wooden battery box covers from the locomotive being wedged between the right hand rear wheel and a prop; also smaller pieces of wood and some brattice cloth were under the other wheels. The post, boards and brattice cloth were that part of the line brattice

which extended across the track just outby the last cutthrough forming a curtain to permit movement of cars to and from the face. The reversing lever was in position for advancing toward the face and the controller lever was between the 3rd and 4th on positions. The motorman's body was lying on its right side, on the right side of the locomotive, face outby, head toward the west rib and under some of the boards and brattice cloth used in the line brattice. This had fallen on him after he had fallen or jumped off the locomotive. The "snapper's" body was lying on its left side, on the left side of the locomotive, face outby, partly in the cutthrough and head toward the heading. There was a coil of shotfiring cable on the snapper's left arm. It is supposed that this coil of wire was lying in the cutthrough when he fell into it. The position of these bodies seemed to indicate that they had attempted to, or actually did, jump from the cab end of the locomotive which was stopped at their feet by the debris on the track. The bodies of the pumper and the face boss were found face down, head outby 18 feet outby the locomotive. The pumper at the east rib and the face boss at the west rib. The face boss' safety lamp was lying at his feet. It was the duty of the face boss to examine each place in the shaft headings for gas immediately before the battery locomotive entered. It is surmised that the pumper and the face boss were riding on the outby end of the locomotive and saw the first flash of flame when the gas was ignited at the open commutator, which would be directly in front of

them, and that they attempted to get away. The position of the bodies of these 4 men is interpreted to indicate that they saw the gas ignited and in the fraction of a second required for the flame to propagate made an attempt to protect themselves. The assistant mine foreman in charge of that section of the mine and whose body was found in the heading at the opposite end of the cutthrough from the locomotive, face down, head outby and lying on his safety lamp apparently had less warning than the others as there was no evidence that he had tried to escape. The body of the miner who worked at the face of the aircourse was found on the heading near the S.W. corner of the second cutthrough from the face. It appeared to have been rolled more or less by the force of the explosion traveling outby, a flame safety lamp was found near the east rib 26 feet inby the body, (Note:- All the safety lamps referred to here were key locked non-permissible type), the miner's cap was caught on the corner of an empty car about half way between the body and the safety lamp and the remains of a dinner pail were found on the heading 25 feet outby the body. The empty car referred to above was off the track and in a position that indicated that it had been derailed by the force of the explosion traveling outby.

While there were a number of places in the mine where overcharged shots had been fired and the coal scattered several feet back from the face, there was no evidence of a blown-out shot or other evidence in support of a theory that the ex-

plosion may have originated at any point other than near the face of the shaft headings.

As shown in Appendix IV, analyses and discussion of air samples taken after the explosion, considerable gas was liberated in the shaft headings, furthermore gas was liberated freely in 9, 10, 11, 12 and 13 S.W., the main dip headings and the new slope headings, through all of which the air current passed before it reached the face of the shaft headings. The conjecture is that there was an interruption in the ventilation that allowed gas to accumulate and form an explosive mixture at the highest point near the face of the shaft headings. This highest point was directly over the battery locomotive near the last cutthrough.

Officials of the mine stated that the automatic doors forming an air lock on the main haulageroad near the mouth of the mine were out of order and 2 men who had been working there, nearly all of that day making repairs, were killed. The condition of these doors may have been such that the volume of air in circulation was reduced considerably if not entirely cut off from the most distant workings.

The presence of 2 or 3 per cent of methane in the air current would materially offset the wet condition of the shaft headings and be an aid to propagation. The absence of coke deposit in the shaft headings, except in rooms and side entries

which were dry and dusty, gives support to the conclusion that the air current in these headings was carrying considerable methane. The presence of large quantities of coked dust in all other parts of the mine through which the explosion extended indicates that propagation therein was due to the presence of coal dust.

LESSONS TO BE LEARNED.

Probably the most important lesson to be learned from the conditions as they relate to this explosion is that dependable adequate ventilation must be provided to insure freedom from accumulations of explosive gas.

It is of equal importance that the men whose duty it is to inspect for gas should not only be capable of detecting small percentages of gas but they should also be men who are aware of and recognize or fully realize the danger there is in small as well as large accumulations of gas. The two officials who were within 50 feet of the supposed origin of the explosion surely ^{should} must have had some knowledge of the condition of the atmosphere in the shaft headings.

The conditions as they relate to this explosion show that when a mine is electrically equipped only equipment of the permissible type should be used where gas is likely to be encountered.

The long entries through which the explosion propagated before reaching the main body of the mine was, in the estimation of the officials of the mine, naturally very wet. ^{The results} This con-

of the explosion show that wetted dust cannot be relied upon to prevent propagation, especially if there is methane in the air.

Probable Cause of the Explosion.

In the judgment of the Bureau investigators the cause of the explosion was a failure or interruption of the ventilation allowing gas to accumulate at or near the face of the shaft headings. This accumulation of gas was ignited by sparks or arcs from an open type storage battery locomotive which was advancing toward the face of the shaft heading air course to pull out a loaded mine car.

The supposed interruption of the ventilation may have been due to a short circuiting of the air at the automatic air lock doors on the main haulage road near the mouth of the mine or by a door having been left open in any one of the headings between the shaft headings and the mouth of the mine. A study of the ventilation of this mine shows that there were six or more single doors, any one of which if left open, would short circuit the air and cut off ventilation from the main dips and the shaft headings.

RECOMMENDATIONS

The purpose of the investigation of mine explosions by the engineers of the Bureau of Mines, is to provide a means whereby the Bureau's Staff may study in detail the contributing factors, that they may formulate recommendations that will tend to reduce, if not entirely prevent, loss of life and damage to property by

such explosions. To ward off the possibilities of such disasters the following recommendations are offered:

1. The outstanding recommendation for this particular case is that adequate and dependable ventilation be provided by circulating air through the mine in such quantities that there will be no possibility of gas accumulating and in such a manner that there will be no interruption of the normal flow of air at the working faces.
2. The ventilating current should have enough splits so arranged as to give each pair or set of headings in gassy portions of the mine a strong fresh current which has not traversed old workings.
3. The main fan should preferably be operated exhausting and be so located that automatic doors may be eliminated from the main haulage road which should remain an intake; the fan should be in a fireproof housing, should have explosion relief doors or their equivalent, and provision should be made for prompt reversal of the direction of air currents in case of necessity.
4. It is recommended that substantial concrete or masonry overcasts be used instead of doors for directing the main ventilating currents.
5. It is recommended that substantial concrete or masonry stoppings be used throughout the mine.
6. At all points where doors are necessary they should be in pairs or so arranged that there will be no interruption of the normal flow of air while men or trips of cars are passing through.

Provisions should also be made for keeping the door closed and for promptly taking care of the ventilation in case of damage to any door.

7. When electric trolleys or non-permissible storage battery locomotives are employed, they should be used only on strictly fresh intake air and should not be used inby the last permanent or substantial fire-proof stopping, or past open rooms or entries which within a distance of 300 feet have faces or workings which give off methane.

8. All electrical machinery used in working places or in return air should be exclusively of a permissible type, and it should receive frequent inspection to insure its maintenance in a permissible condition at all times. Power lines should not be placed in return air or taken beyond breakthroughs closed with a permanent stoppings.

9. When flame safety lamps are required for testing for gas or any other purpose, it is recommended that only a magnetically-locked permissible type be used, and that persons entrusted with and directed to use flame safety lamps be capable men who are aware of and fully realize that a disasterous explosion may originate from a very small accumulation of methane.

10. Workmen are provided with permissible electric cap lamps and their continued use is recommended.

11. The management is commended for supplying the workmen with permissible explosives for blasting purposes, but it is

recommended that only experienced capable employees be permitted to charge and fire shots. All explosives should be used in accordance with the conditions prescribed by the Bureau of Mines and firing of shots should be done electrically.

12. The use of water on the cutter bar of all coal-cutting machines to allay dust is recommended. Water should be used to wet down the coal before it is loaded and at frequent intervals during loading. Loaded cars should also be sprayed before leaving the working face.

13. In order to localize the flame of gas ignitions or blown-out shots, it is recommended that all roadways, airways and working places be thoroughly rock-dusted. The rock-dusting should be repeated at such intervals of time that the percentage of non-combustible matter (ash plus moisture) in the mine dust will be greater than 65 per cent. When the non-combustible content of the dust in any zone or section falls to or below 55 per cent, that zone should be re-dusted immediately. Rock-dusting to be most effective should be maintained to within a short distance of the working faces, preferably less than 40 feet.

14. Any motor road, in which trolley or other non-permissible electric locomotives are used, should be kept especially well rock-dusted, both as to timbers and ribs, as well as floor.

15. The opportunities for the effective installation of rock-dust barriers in this mine are limited. However, approved types may be used as an auxiliary to generalized rock-dusting. Some of the

suitable locations for rock-dust barriers are along the haulage roads, to make up the deficiency in generalized rock-dusting, where there is unusual spillage of coal, and at the entrance to such sections of the mine where only 2 or 3 barriers will be required to effectively isolate the section from other parts of the mine.

16. It would appear advisable to have more than one fire boss for a mine of this extent; and it would be decidedly advisable to have rigid daily pre-shift examination of all accessible parts of a mine known to give off methane.

17. Seals around fire areas in this mine should be kept under daily supervision and should be kept in the very best of repair.

ACKNOWLEDGEMENTS

The writers wish to acknowledge the hearty cooperation of all persons who assisted with the preparation of this report; also the cooperation of the officials of the New England Fuel and Transportation Company and the officials and inspectors of the West Virginia State Department of Mines. The officials of both the company and the Department of Mines offered every facility and opportunity for observing and studying conditions as they related to this explosion.

APPENDIX.

APPENDIX I.

The Elimination of Explosive Hazard by Sealing Mine
and Air Locking Way into Mine in Order to Recover
Mine and the Dead Bodies.

The exploring party had penetrated the mine, restoring ventilation stoppings in order that they could follow fresh air. Upon reaching the 2 south section at the point of intersection with 2 south and No. 1 main face entry, smoke was observed coming out of 2 south and following the air to the return face entry side. Several of the party observed the smoke condition and upon testing the smoky atmosphere with a flame safety lamp, it was found from the reading of the flame cap of the lamp to contain approximately 3.5 to 4 per cent of methane. Where tests were made with the carbon monoxide detector, approximately 0.5 per cent of carbon monoxide was found. The air inby 2 south on No. 2 main face entry contained approximately 0.2 per cent of carbon monoxide. The air returning on No. 6 face entry outby No. 2 south contained approximately 0.5 per cent of carbon monoxide gas, this gas being diluted with the ventilation current short-circuiting a short distance inby 2 south. The carbon monoxide detector showed more than 1 per cent CO 200 feet in the return from 7 north inby No. 6 face entry. The rescue party realized from the gas conditions that no one could possibly be alive inby 2 south section. Every condition indicated that the explosion came from inby this point. They unanimously decided that the first procedure would be to take care of the live men engaged in recovery work, hence it was determined to seal off the mine outby 2 south section straight across the six main face entries. The temporary sealing was completed

about 5 a.m. and the temporary seals were backed up with air-tight stoppings of wood and wood pulp plaster. The rescue and recovery work was under the direct charge and supervision of R. H. Lambie, Chief, Department of Mines, West Virginia. Mr. Lambie made an inspection of the sealed area; also sent a rescue crew into the face entry and up 2 south section to see if they could locate the fire, and obtained information from men present at sealing as to the condition of mine atmosphere previous to sealing. He then proceeded to devise a plan for the recovery of bodies inby seals by perfecting an organization composed of State Inspectors, Company officials, Bureau of Mines men, Mine Safety Appliances Company's officials, and other well known rescue workers. A complete list of these is compiled in this report. It was decided to air-lock by crews wearing self-contained oxygen breathing apparatus to a point inby 5 south section; cutting off all face entries and the north section outby 5 south section; also go up 5 south and seal off connecting openings to 6 south section, thereby splitting the mine into three sections and cutting off the face section that was known to have been generating explosive gas previous to the explosion. Fifteen air-locks and over eighty air-tight stoppings were built in order to divide the mine into three sections. There were approximately 160 rescue apparatus crew shifts of eight and six hours duration. At one time there were in action 21 rescue crews with over 100 self-contained oxygen breathing apparatus and over 100 All-Service gas masks. The officials in charge and builders of fresh-air stoppings carried self-rescuers for their

protection. The sealed area at one time contained 4.4 per cent CO, with the oxygen a little over 11 per cent, and at one time the air in 2 south section analyzed over 6.5 per cent methane with the oxygen content around 14 per cent. After the completion of the air-locks section, exploring crews made trips in various directions but could not locate any fires. The fire on the 2 south section was found to have been extinguished by the low oxygen content but on restoring ventilation in the 7 north section a small active fire was encountered and extinguished.

In order to build air-lock stoppings and split the mine into the three sealed sections, it required seven days work and each 24 hours was divided into 4 shifts of 6 hours duration. The rescue apparatus and gas masks of every man going underground were charged and inspected by men supervising this work. Approximately 5000 pounds of carbon dioxide and 10,000 cubic feet of oxygen were used by the rescue crews wearing apparatus.

Following is a complete list of the 21 oxygen breathing apparatus teams and the men in charge of same, also West Virginia State officials, New England Fuel Company officials, and Mine Safety Appliances Company officials.

No. of teams	Name and location of Company.	Men in Charge of teams.
4	Bethlehem Mines, West Virginia	J. V. Berry R. Reid
2	Consolidation Coal Co., West Virginia	F. Bedell J. Zorn

No. of teams.	Name and Location of Company.	Men in Charge of teams.
2	New England Fuel and Transportation Co., Grant Town, W. Va.	Thos. King
1	McKell Coal Co., West Virginia	Mr. Ward
1	E. E. White Coal Co., West Virginia	Mr. Morgan
1	Wheeling Steel Corp., Steubenville, Ohio	Alex Grant
1	Morgantown Gas Coal Co., West Virginia	
2	Pittsburgh Coal Co., Pennsylvania	Reese Nichol Thos. Eagle
2	H. C. Frick Coke Co., Pennsylvania	B. Murphy C. Lutton
1	Penelec Coal Corp., Pennsylvania	D. Boyle
1	Vesta Coal Co., Pennsylvania	C. O. Roberts
1	Pittsburgh Terminal Coal Co., Pennsylvania	Jas. Humes J. Benedict
1	Orient Rescue Station, Orient, Pennsylvania	C. Opperman
1	Connellsville By-Product Co., Pennsylvania	J. Gall

Officials from the State of West Virginia present were Governor Gore, Major O'Connor, R. M. Lambie, Chief of the Department of Mines, State Mine Inspectors Griffiths, Evans, Jarrett, Lilly, Conners, Kramer, Riggleman and Sandridge, and Safety Directors, Morris, McGee and Farley.

Officials of the New England Fuel and Transportation Company present were Mr. G. A. G. Wood, Vice President; Mr. J. J. McSweeny, Vice President; Mr. J. W. Devison, General Superintendent of Mines; Mr. J. A. McKay, Mine Superintendent; Mr. John Spiker,

Mine Foreman; Mr. R. Roth, Superintendent, Federal No. 1 Mine;
Mr. Thos. King, Engineer; Mr. Thos. Ashcroft, Purchasing Agent;
and Mr. James McKenna, Assistant General Superintendent.

Officials present from the Mine Safety Appliances Company were Messrs. J. T. Ryan, G. H. Deike, Loeback, Lewis, Kennedy, Riggs, Jones, McClelland, Stanton, Rock and Setlemire.

APPENDIX XII.

Report of the Medical and Surgical Cases Relative the
Everettville, W. Va. Mine Explosion.

By Dr. O. V. Linhardt.

The date of the explosion was April 30, 1927 about 3:35 p.m., and I did not report at Everettville, W. Va. until May 4, 1927, at or about 10 p.m.

Before my arrival many men had been examined and many rejected, and upon the advice of some of the Engineer's of the U.S. Bureau of Mines, many of these were re-examined and accepted. The physician with the company of National Guard men had examined these men and he acted according to instructions of the Engineer's that these men should be given some sort of exercise and if their pulse did not return to normal within 2 minutes that they could not be accepted, as well not to accept anyone with a pulse of over 100.

I might add that the Medical Staff consisted of the following men:

Dr. J. R. Tuckwiller - the Company's physician.
Dr. B. F. Conway - assistant to Dr. Tuckwiller.
Dr. A. G. Bowles - with the Glenwhite Mine Rescue Team.
Dr. J. C. Collins - Company's physician at Granttown, W. Va.
The Major-Medical Corps with the National Guard.
Dr. O. V. Linhardt - with the U. S. Bureau of Mines.

However, Dr. Tuckwiller's time was occupied every hour of the day and night in assisting the State compensation men with the identification of bodies. Dr. Conway was absent from the town during the entire time I was there, Dr. Bowles took care of the Glenwhite Rescue Team only, and Dr. Collins simply came perhaps for an hour at a time every other day. The Major of the Medical Corps with the National Guard took care of the men in the Guard, so that, as usual, the Government physician was left to do all the medical work.

For the Rescue teams, a total of 80 men were examined, of which 3 were rejected: 1 for tuberculosis (diagnosis concurred in), 1 for myocarditis - with hypertrophy of the heart, 1 for a mitral leison. Of the remaining 77, 16 were re-examined because of "nervous conditions", and every one of the 16 re-examined was finally passed as physically fit.

In making these examinations, we followed the form No. 141 and 142, U. S. Bureau of Mines, except that we did not follow the 2 minute period. Some were given as much as 22 minutes between the exercise and the second and third examination before they were accepted.

Analysis of the Re-examination of the 16 Men.

Name	Team	Age-pulse-B.P.	2nd Exam.	3rd Exam.	Min.
Gall, James	Steubenville, Ohio	33-102-140*78	pulse 92		15
Kelly, James	" "	35-100-130*80	" 80		11
O'Rouke, James	Pittsburgh Coal	35-102-122*88	" 99 P-80		15
Plumeret, Frank	" "	41-120-122*80	" 98 P-80		22
Drexler, Frank	" "	35-110-122*80	" 80		8
Young, John	" "	39-70-160*100	B.P.-150-96		10
O'Loughten, James	Frick Coal	45-102-180*100	B.P.-150*98 P - 98		15
Schaeffer, James	" "	27-112-120*80	pulse 100		8
Clark, J. E.	Bethlehem Coal	30-104-124*78	" 100		4
Hughes, James	Pittsburgh Term.	45-72-140*88	B.P.-122*80		10
Riggs, W. T.	" "	30-106-140*90	pulse 90		10
Benedict, Joseph	" "	38-79-155*85	B.P.-135*78		20
Whitfield, R. J.	Elm Grove	37-82-160*90	B.P.-122*82		10
Paulie, E. P.	Grantown	29-102-145*82	pulse 100 P - 80		17
Kendall, Roy	Consolidated	30-106-124*80	" 78		6
Norman, Harry	Vesta Coal Co.	24-101-120*78	" 76		7

This report shows that each and every man did not bring his pulse down to the required number within two minutes according to Form No. 142 (Bureau of Mines), but the different Engineers requested that every man be given a special opportunity, as they were all well trained men in mine rescue work, and well trained men were hard to obtain. It is my personal opinion that everyone of the above men are simply of a nervous temperament and the simple fact of coming before the doctor excites them, whereas dangerous work like wearing a helmet in an atmosphere of CO would not excite them the least bit. This is especially true of the first two men, as they were examined at Pungo, W. Va., and the report at that time was identical to this one.

In making the report out relative sick and injured, only the cases which might be considered serious or interesting are listed, the minor injuries like, for example, a small laceration, etc. are not listed, as well as those that simply came for some light laxative or purgative. Injuries totaled 20 and illness 19 cases.

Injuries-

Diagnosis	No. of cases	Results	Remarks
Foreign body in eye	2	Excellent	
Laceration and severe burn	1	"	
Laceration hands	1	"	
Laceration scalp	2	"	
Laceration fingers	2	"	
Laceration foot	1	"	
Laceration eye lid	1	Sent to eye specialist	
Burn from cement	1	Excellent	
Spain - finger	1	"	

Injuries cont'd.

Diagnosis	No. of cases	Results	Remarks
Penetrating wound (nail in foot)	3	Excellent	
Infection - tip of finger	1	Good	
Infection - mouth	3	Good (due to rubber mouth piece)	
Contusion - limb	1	Excellent	

Illness (including CO poisoning)

Diagnosis	No. of cases	Results	Remarks, etc.
Tuberculosis	1	Referred to his family physician	
Diarrhea	2	Overdose of Pluto water (Nurse)	
Constipation - severe	7	Excellent	
CO poisoning	7	Each case described separately	
Bronchitis - severe	1	Fair - removed to Fairmont	
Influenza (Mild)	1	Excellent	

CO poisoning

Gatehouse, J. T. - age 29, member of the Orient Team, overcome at 2:38 a.m., May 5, 1927 - given oxygen, hot black coffee, etc. - kept warm and put to bed in "tent hospital" all that night. Blood examination showed 30% saturation. His symptoms were as follows: severe headache, throbbing of his temples, sense of being tired, was not giddy. When he awoke in the morning he was in excellent physical condition, except for a dull headache. (luminal et sodii Grs., 1 and 1/2 were given him at 4 a.m.).

Case 2 - Hencil, Henry - age 38, Penlac Coal Co., overcome at 3:05 a.m. on May 5, 1927 - given oxygen-alcohol drams Iss in hot water, and codeine sulphas Grs. 1/2 with acetysalicylic acid Grs. v. Blood examination showed 15% concentration, or rather, saturation. Though his blood showed only 15%, his headache seemed much more marked than the above case, and this was his only symptom.

Case 3 - Grant, Sandy - Captain of the Steubenville, Ohio Team, received some little CO on three different occasions since being on this "job" and at 5:00 p.m. on May 5, 1927 had to stop working due to nausea and a headache. He also vomited once. His headache was very marked and severe. He was given "Hinkel's tablets No. 2" - codeine sulphas Grs. 1/2 with acetysalicylic acid grs. v. and caffeine citrate Grs. 1/2, repeated in 2 hrs. No blood examination made.

Case 4 - Jeffers, C. W. - age 34 - Consolidated Coal Co., May 7, 1927. On shift from 2 to 8 p.m. CO poisoning. Blood examination only trace, headache most marked symptom.

Case 5 and 6 - Spiker, J.W. and King, T.C. - former Mine Foreman for the New England Fuel and Transportation Co., the latter a registered druggist who operates a drug store for this company at Granttown, W.Va., on May 8, 1927 3:20 p.m. both entered mine, both had gas masks but neither

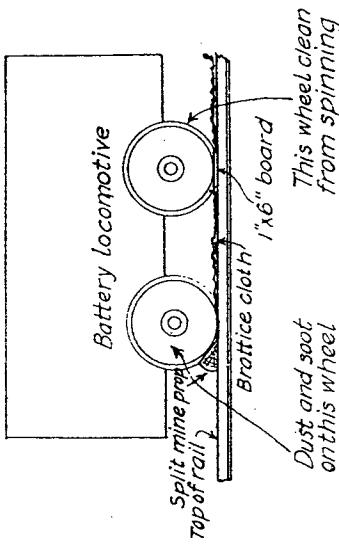
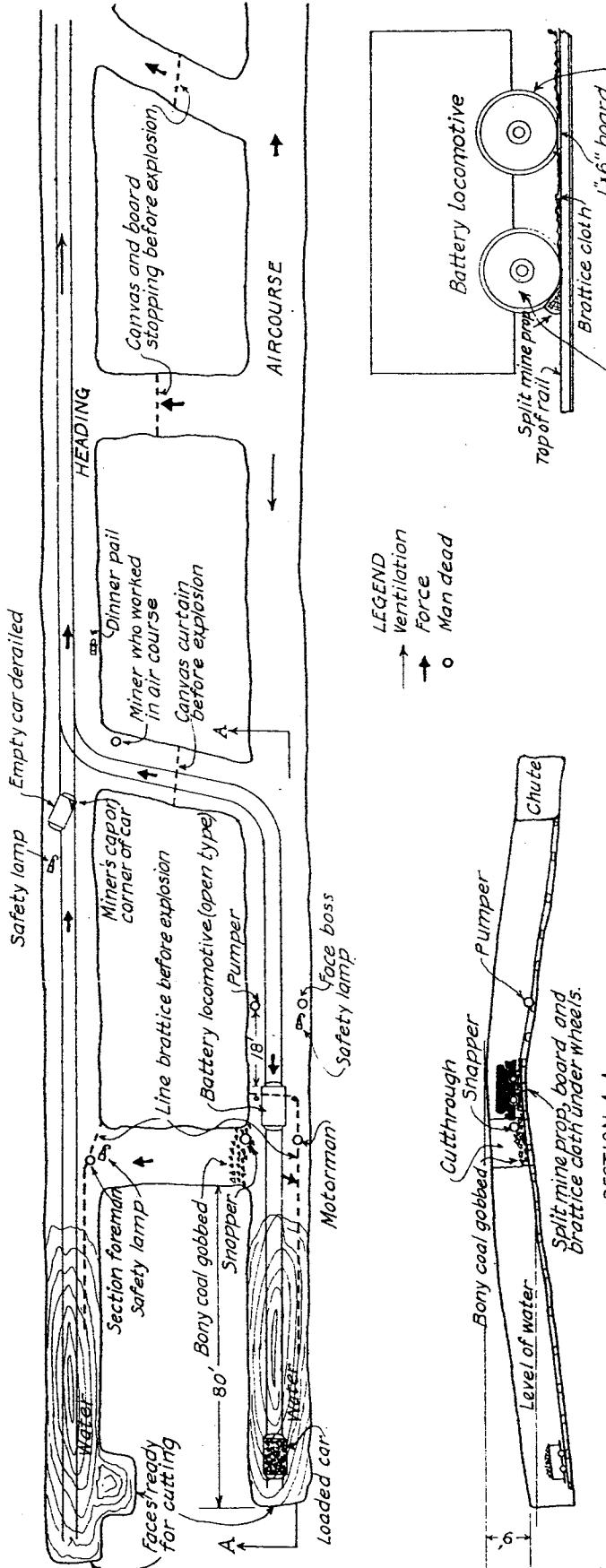
one took the trouble to wear them. Both received some little CO. Blood examination on both showed trace. Inhalator used on both, using CO-2-5% and O-2-95% 10 minutes, some little nausea and marked headache.

Case 7 - nurse failed to get data on this case, however, blood examination showed only a trace, and headache was most prominent symptom. This man was given no medication of any kind. He was told to lie down in the hospital tent which he did for about 4 hours and then left for his home.

It is interesting to note that in all of the 7 cases of CO poisoning, from trace to as high as 30% saturation, that "HEADACHE" was the most prominent symptom and always present, whereas "NAUSEA" and more so "vomiting" was present in only 1 case, and this case (no blood examination) was an individual who was exposed to CO on at least 3 different occasions,- 1 day apart each time. This man, however, only lost 1/2 day's work, or 4 hours.

Another interesting thing is that in the case of "King, T. G." according to his own explanation as well as "Gatehouse, J. F." who showed a 30% saturation, the headache was more severe in the case of "King" than the latter patient.

Only 1 case showed the symptom of "sense of being tired". The temperature in all 7 cases was always normal, the pulse rate higher in those showing more saturation.



Detail sketch showing face of shaft headings after the explosion of April 30, 1927,
Federal No. 3 Mine, Everettville, W. Va.