REPORT OF EXPLOSION MINE NO. 2 BLACK DIAMOND COAL MINING COMPANY DRAKESBORO, MUHLENBURGH COUNTY, KY.

DECEMBER 18, 1928

By

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and

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At about 7:45 P.M. December 18, 1928, an explosion occurred in Mine #2, of the Black Diamond Coal Mining Company, Drakesboro, Muhlenburgh County, Kentucky. The explosion occurred about one hour and forty-five minutes after the night shift had started to work. There were eleven men in the mine, six of whom were killed and the balance escaped unassisted. Those who escaped were working on the intake, side of the explosion.

It is believed that the explosion was caused by a body of gas that had been liberated from caving rooms in the 5 west 4 north entry. It is the supposition that the ignition of the body of gas was due either to a fall of slate at room #8 on the 5 west, causing an arc between the trolley wire and the rail, or that the gas accumulated and was carried in the air current over the open lights of the men who were killed. It may also have been ignited by a trolley locomotive that had been used by one of the deceased, and was found nearby with the controller in the on position. The explosion was propagated to some extent by coal dust. Mr. G. T. Powell, Foreman Miner, U. S. Bureau of Mines Station, Evansville, Indiana, was notified about 1 A.M. December 19, and after driving about 120 miles over some very rough roads, arrived at the mine about 7:30 A.M. and assisted with the recovery work until all of the bodies were recovered.

LOCATION AND OWNERSHIP

Mine #2 is located about one mile southwest of Drakesboro, Muhlenburg, County, Kentucky. It is owned by the Black Diamond Coal Mining Company, which is now in the hands of a receiver. The mine is served by the Louisville and Nashville Railroad.

The officials of the company are as follows:

President, W. W. Bridges, Drakesboro, Kentucky Mine Manager, E. C. Lower, "

Mine #2 is working the No. 9 bed of the Kentucky Series, which averages about 5' 6" in thickness at this operation. The coal seam is reached by two shafts, one a two-compartment hoisting shaft and the other a two-compartment air shaft, each about 250 feet deep. The air shaft for Mine No. 2 also serves as an air shaft for mine No. 3 which is working the No. 11 bed. The No. 11 bed is about 65 feet above the No. 9 bed.

The roof is a black slate which contains pyrite concretions. The floor is a fire clay.

METHOD OF MINING

The coal bed is worked on a panel system. Cross entries are driven 860 feet apart and panel entries 400 and 525 feet apart. All entries are driven 10 feet wide with 17 foot pillars between. Rooms

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are driven 24 feet wide, 190 and 250 feet deep, with 13 foot pillars betwen. No room or entry pillar coal is extracted. The coal is undercut before it is shot. The cuttings are not loaded out before the shots are fired.

About 145 men are employed in and around the mine and produce about 1000 tons per day.

An analysis of face samples of coal collected from a nearby mine will be found in the appendix.

HAULAGE

Mechanical haulage is used throughout the mine. One trolley locomotive is used for main line haulage and five cable and reel locomotives are used for gathering the coal at the face. The cars are constructed of wood, of the lift end-gate type and have a capacity of about $2\frac{1}{2}$ tons. About six inches of "topping" is placed on them when loaded.

Forty and thirty pound rails are used on the entries and twenty pound rails are used on the rooms. The track gauge is 42 inches. The main haulage is on the roturn air.

UNDERGROUND EQUIPMENT

The underground machinery consists of 6 electric locomotives, 3 Goodman and 2 Sullivan Shortwall coal cutting machines, 2 steam pumps and 1 motor driven booster fan. All underground electrical equipment is of the non-permissible type and is operated on 250 wolt direct current.

It was observed that the electric wires that carried the current for the operation of the motor at the booster fan, were nailed to props. This method of installing electric wires should be discontinued as it represents a fire hazard. The trolley wires were very well hung.

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LIGHTING

All underground employees use open carbide lights. The roadways are lighted with electricity. The night boss, who also acts as examiner, and the mine manager, use a Koehler key-locked flame safety lamp. They also carry carbide lamps when making examinations with the flame safety lamp.

EXPLOSIVES

The coal is shot with black powder and fuse. Shot-firers shoot the shots. The miners charge and tamp their own shots. Fine coal is used for stemming and the tamping is done with copper tipped tamping bars.

The use of black powder in coal mines is extremely dangerous. About one-third of our coal mine explosions have been caused by the misuse of explosives and in the majority of cases black powder was the explosive in use. In addition innumerable fires have been caused by black powder or dynamite shots in coal mines and one mining company having fewer than ten mines, had a record (covering a period of several years) of more than one fire per week from blasting with black powder or dynamite.

The use of fine coal or other inflammable material for stemming much increases the hazard of the use of black powder. To reduce the hazard of blasting in coal mines, the U.S. Bureau of

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Mines recommends the use of permissible explosives, electric detonators, and non-inflammable stamming.

MOISTURE AND HUST

The live workings are dry. Practically all of the water made in the mine is coming from old works. Only two steam pumps are required to keep the water pumped out.

The face workings are dry and dusty. The coal dust appears to contain very little incombustible material. The roadways are sometimes watered with a water box. No rock-dusting has been done in the mines.

(See appendix for analyses of dust samples collected). GASES AND VENTILATION

The mine is ventilated by a 4' x 4' Jeffrey fan, which is belt driven by a steam engine. It is operated blowing and is so constructed that the air current can be reversed if necessary. At the time of the investigation it was delivering 24750 cubic feet of air per minute with the split to the No. 3 mine closed. The company does not maintain an auxiliary unit for operating the fan in case the steam engine is disabled. The mine is ventilated by one continuous air current.

The booster fan is located on the main intake about midway between the 8th and 9th south entries. The installation of this fan is such that it practically blocks the entry, and when it stops, the only air that can get by must pass through the fan. There is no remote control on the fan motor. The writers were informed that each time the circuit breaker came out the fan stopped and was not started again for

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sometime afterward, and offtimes it is stopped by someone connected with the management, presumably to save power cost. At 2:30 A.M. when the night shift quits work, the power is cut off the mine and the booster fan does not operate again until the day shift starts to work, which is 7 A.M. The writers are of the opinion that the installation and operation of this fan is an extreme hazard and entails an expense for operation that would bring better returns, as well as reduce the hazard, if it were applied to improving the general ventilation.

The fan should at least be equipped with doors that open as soon as the fan stops, so as not to retard what ventilation comes from the main fan.

Stoppings in the entry crosscuts are constructed with native lumber and are not tight, neither are they plastered, and all leak very badly. Curtains are used for deflecting the air currents on the haulageways.

An air measurement on the main intake, about 600 feet inby the bottom of the air shaft shows that there is about 24750 cubic feet of air per minute, going into the mine. Another measurement made on the main return, and about 900 feet inby the main shaft bottom, shows about 10440 cubic feet of air per minute, coming out. Another measurement taken at the booster fan, which is about 700 feet outby the nearest face workings, shows 4,400 cubic feet of air per minute going in at this point. Thus, approximately 20,000 cubic feet of air per minute is lost, between the main intake reading and the point near the booster fan. These measurements indicate that the ventilating system is in a deplorable condition. If the cost for the operation of the booster fan was expended

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for repairing and plastering stoppings, and the stopping of other air leaks between the downcast and the booster fan, the volume of air at the face workings would be much larger than it now is with the booster fan in operation.

The mine is considered as being non-gaseous by the State Department of Mines and the company officials. The mine manager stated that he had been in charge of the mine two years and during this time he had not detected any gas, except once, when a pair of entries were passing through a fault. However, the writers detected gas during the investigation, in a pocket in the roof at the mouth of room No. 5 on the 6 west 4 north, which is in the immediate explosion area. The writers did not make a close exemination for gas in the rooms on the 5th and 6th west 4 north entry, as the roof was very bad and several of the rooms were still scaving.

(See Appendix for analyses of air semples taken in the mine).

The mine is examined by the night boss, who quits work about 2:30 A.M. before the day shift reports for work. The night boss reports his findings to the mine manager, but no record is kept of the reports. The writers were informed that the night boss had very defective vision and it is questionable whether or not he was able to detect gas with a flame safety lamp.

MINE CONDITIONS IMMEDIATELY PRIOR TO THE EXPLOSION

The fan on the surface had been in continuous operation but the booster fan had been stopped at times during the day.

About 2:45 P.M. a track layer started to go to room No. 11 on the 5th west 4th north entry to get a rail bender. When he get was

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opposite the mouth of room No. 8, his carbide light ignited a body of gas and the force of the explosion knocked him down to the mouth of room No. 7. As he lay on the floor he could see the flame traveling toward the face of rooms 6, 7, and 8. This explosion was mild and did not burn the tracklayer, nor cause any damage. The mine manager stated that after this explosion, he made an examination of all rooms on the 5th and 6th west entries, with a flame safety lamp, but could not find any trace of gas. He completed this examination about 4:30 P.M.

PREVIOUS EXPLOSIONS

About seven years ago a gas explosion occurred in Mine No. 2 which killed one mine examiner.

In 1910 a gas explosion occurred in a mine at Browder, Kentucky, resulting in the death of fifty-seven men. This mine is located about one and one-half miles southeast of mine No. 2. PROPERTY DAMAGE

The explosion was local and affected only a small section of way the mine. There is very little damage done outside the 5th and 6th west entries. All of the stoppings are blown out between the 5th and 6th west entries. Many timbers were also blown out on these entries, which permitted considerable slate to fall. The trolley wire on the 5th and 6th west was knocked down. Fifteen emptise were wrecked at the mouth of the 5th west entry. The cable reel on a coal cutting machine was broken and thrown about 20 feet from the machine. Some track on the 6th north entry was blown out of alignment.

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The unaffected territory could have been operated the day following the explosion. It is believed that, with the exception of the large falls of slate on the 5th and 6th west entries, the explosion area could have been operating within three days.

FORCES

The general force appeared to start at room No. 8 on the 5th west entry and radiated in all directions. The stoppings between the 5th and 6th west entries were blown toward the 6th west. A trip of cars which had been placed on the 5th west inby the cross-over between the 5th and 6th west, was wrecked at the mouth of the 5th west. Considerable timber. which had been placed on the 5th and 6th west entries, was blown against the right rib of the 4th north entry. The floor of the 5th west entry, near the intersection of this entry with the 5th north, was swept clean and considerable debris blown into the mouth of the 5th west 6th north entry. Rooms Nos. 1, 3, 7, 8, and 10 on the 5th west are driven through to the 4th west 4th north entry and part of the force traveled outby through some of these rooms to the 4th west entry and thence to the 5th and 6th north entries, where it deposited some debris on the right rib of the 6th north entry and also moved the track out of alignment. Although one of the victims had his neck and jaw broken and another had his skull fractured, there is very little evidence of force where the bodies were found.

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EVIDENCE OF HEAT AND FLAME

There are some coke deposits on props, between rooms 10 and 16 on the 5th and 6th west entries. There are also coke deposits on the props in these rooms for a short distance inby the max' entry. There is very little evidence of heat on timber or other material. The bodies of the victims de not show any evidence of burns.

RECOVERY WORK

As scon as the mine manager was notified of the explosion he selected three men to accompany him and went into the mine for the purpose of starting recovery work. Before they had some very far, two of the party stated that they did not care to go farther. The mine manager instructed these two men to return to the surface and he and the other employee continued on their way until they came to the mouth of the 4th north entry where they met two of the night shift men coming out. The mine manager instructed them to extinguish their carbide lights and accompany him to the explosion area. The party of four then proceeded to 5th north entry and worked their way to the intersection of this entry with the 5th west 4th north, without restoring ventilation or having gas masks or other protection from irrespirable gases, except a flame safety lamp. They then decided to try and go as far as room No. 14 on the 5th west. At room No. 15 the safety lamp was extinguished. The mine manager then decided to take a deep breath and make a run to room No. 14 and return before taking another breath. This, he was unable to do, and as a result, was overcome by the irrespirable gases. The other three man rescued the mine

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manager and carried him to the intake air near the mouth of the 5th north entry and then went for assistance.

A second party headed by the mine manager, and the assistant mine manager of a mine at Browder, Kentucky, then entered the mine and worked their way to the 5th west 4th north entry by travelling in the 5th north entry. A crew got as far as room No. 15 on the 5th west when the mine manager and his assistant were overcome. The balance of the party rescued these two man and all of the man in the recovery party returned to the surface after which the State Mine Inspector issued an order that no one would be permitted to enter the mine until after the arrival of Mr. C. T. Powell, Foreman Miner of the U. S. Bureau of Mines Station, Evansville, Indiana. However, the team from the West Kentucky Coal Company, Earlington, Kentucky, arrived at the mine about 3 A.M. December 19, and after waiting until about 7 A.M. for Mr. Powell (Mr. Powell's truck was mired in the mud between Central City and Drakesboro, Kentucky) it was decided that the West Kentucky Coal Company team should go into the mine and proceed with the recovery work. Shortly after this team entered the mine, Mr. Powell arrived.

The ventilation was restored temporarily with canvas stoppings. The air was taken up the 5th north entry to the 5th west 4th north. These entries were explored up to rooms No. 9 on the 5th and 6th west 4th north entries, without finding any live men or bodies. Here the progress of the crews was stopped by large falls of slate over which they could not pass. It was then decided to retreat and change the ventilation, by forcing the air up the 4th north entry. After changing

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the ventilation the recovery grews returned to the surface until the 4th north entry was ventilated. After waiting three hours, the recovery crews re-entered the mine and explored the 4th north entry and found the six bodies a short distance outby the mouth of the 5th west 4th north entry. All of the bodies were lying within a distance of 100 feet.

Three of the men who escaped came out immediately after the explosion. Two of these men were working in the 1st west 6th north and the other one was working in room No. 1 on the 12th south. The two men whom the mine manager met at the 4th north entry as they were coming out, were also working in room No. 8 on the 12th south. RECULTS OF INVESTIGATION

On December 20, and 21, an investigation was made by the writers, accompanied by the District State Mine Inspector and two of the company employees. The following information was obtained.

After the explosion, which occurred at 2:45 P.M., and the mine manager had completed his examination of the 5th and 6th west territory, which was about 4:30 P.M., he told the two machine men that he could not find any trace of gas in the above territory and that they could cut the face of room No. 16 on the 6th west, or move to the 4th north entry where there were three places to undercut, and if they decided to cut in the 4th north section first, they were to wait at the mouth of the 5th west 4th north entry until the night boss had again examined this territory and pronounced it safe. In compliance with the mine manager's instructions, the machine men had completed their work in the 4th north section and had moved their machine to the mouth of the

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5th west entry.

No. 11 room on the 5th west was driven up its distance and two of the men who were killed were instructed to recover the rails in the room before it caved. The mine manager instructed the night boss to make a thorough examination of the 5th and 6th west section before he permitted any of the men to start working in these entries.

The trip of empties that was wrecked at the mouth of the 5th west entry had been placed inby room No. 1 on the 5th west about 7 P.M. The motorman stated that he did not see any of the mon who were killed when he placed the empties on the 5th west entry.

The bodies of the night boss and machine runner were the first discovered and were found about 100 feet outby the machine. The body of the shot firer was found in the first crosscut outby the mouth of the 5th west entry. He had pulled his overall jacket over his head and held a flashlight in his hand, but did not have any cap on his head. His neck and jaw were broken. The bodies of the other three victims were found lying between the crosscut, where the shot-firer was found, and the place where the bodies of the night boss and machine runner were found.

A carbide lamp, miner's cap, and the bonnet, gauzes and expansion ring of a safety lamp were found in the aircourse about ten feet outby the crosscut where the body of the shot-firer was found. If it be true that the vision of the night boss was defective he may have given the safety lamp to the shot-firer for the purpose of making the examination and the shot-firer was preparing to light the lamp when the explosion occurred. Two trolley locomotives were found jammed together about 70 feet

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outby the mouth of the entry. The controller on the outby motor was open and the trolley pole broken. The controller on the inby motor was set on the off position. One of these locomotives had been used by the night boss and the other by the shot-firer.

Since the bodies were found within a distance of about 100 probable feet it is possible that the gas had been discovered and the victims were discussing the proper method to handle it when the ignition took place or they were waiting for the shot-firer or night boss to examine the territory prior to going to work.

LESSON TO BE LEARNED FROM EXPLOSION

It is certain that the explosion was due to the ignition of a body of gas; it is impossible however, to say definitely how it was ignited, as all those in the affected area, were killed. It may have been due to the miners' open lights, to the trolley locomotive, or possibly to a fall of rock in the 5th west, tearing the trolley loose, causing a short circuit. The investigation following the explosion, indicated very clearly;

1. That the mine had insufficient ventilation.

2. That a feeling of security from gas explosions develops among officials of supposedly non-gaseous mines, and as a result, proper precautions are not taken to prevent dangerous accumulations of gas.

3. That squeezing and falling strata should be patrolled at all times by a competent examiner who should be provided with an approved flame safety lamp.

4. That unapproved lights and mining equipment should not be used.
5. That too much time elapses between the examination of the

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working places and starting time of the employees.

RECOMMENDATIONS

1. That-the Ventilation be improved immediately by plastering stoppings and stopping other leaks between the air shaft and the face workings. should

That Mine No. 2 be provided with an air shaft that will be independent of mine No. 3, which is working the #11 bed.

The Bureau of Mines recommends that the quantity in cubic feet, of pure intake air, flowing per minute in any ventilating split shall be at least equal to 100 times the number of men in that split. The Bureau of Mines defines pure intake air as follows:

(a) Air which has not passed through, or by, a ny active workings, and (or)

"(b) Air which has not passed through, or by, any inactive workings unless these workings are effectively sealed; and

"(c) Air which is free from poisonous gas and by analysis, contains not less than 20% oxygen (dry basis) and not over 0.05 per cent of inflammable gas. should

That At least one more split be provided in the ventilating system.

2. All old workings should be effectively sealed.

3. That Only competent mine examiners be employed, and the examiner's vision tested regularly, to determine whether or not he can detect a gas cap. The examiner should be provided with a permissible flame safety lamps

4. The U.S. Bureau of Mines recommends the use of permissible lights and electrical equipment in gassy and dusty coal mines.

5. The U. S. Bureau of Mines recommends the use of permissible explosives fired electrically, in gaseous and dusty coal mines and that non-inflammable material be used for stemming.

6. To prevent the propagation of mine explosions, the Bureau of Mines recommends the rock-dusting of all coal mines except anthracite mines, in every part, whether in a damp or dry condition. Sufficient amount of rock-dust being applied so that the total amount of incombustible material will be maintained at 60% or more at all times. For each one per cent of methane in the return air it requires 10% more incombustible material.

7. Each working place should be examined not more than two hours before the men report for work.

8. Whenever the strate is squeezing or falling in any section, it should be examined at regular intervals by a competent examiner, so as to detect a possible dangerous accumulation of methane.

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APPENDIX

The following is an analysis of air semples collected in mine No. 2 on December 20, 1928, by G. T. Powell, Evansville and A. U. Miller, Vincennes, Indiana.

Lab.No.	Location	<u>C02</u>	02	CO	CHA	N2	Vol.air per min.	CH4 pr.hr.	CH4 ea 24 hours
49581	Main West rot 900* inby hoisting shaft	54	18.43	•00	1.22	79.81	10440	7642	18 3410
49583	Return 5 West 10' inby 4th north	.53	18.27	•00	1.79	79.41	Vel. too) low fo	r reading

Analyses made December 31, 1928, U. S. Bureau of Mines, Pittsburgh, Pennsylvania by W. P. Yant, Chemist.

The above samples were taken the day following the explosion, when the fan was running at its normal speed and they had the split to the No. 3 mine, cut off, so that all of the air was going into mine No. 2. Both of the samples show a very low oxygen content and a very high percentage of methane. The above analyses indicate that the mine is liberating large quantities of methane, to be considered a non-gaseous mine.

Teste made by the U. Sf Bureau of Mines show that 100 cubic feet of mixture of methane and air will create a mild explosion, and 200 feet of a similar mixture will make a violent explosion. Sample bearing laboratory No. 49581 shows that 7642 cubic feet of methane is passing out of the mine per hour, which makes a total of 183410 cubic

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feet every twenty-four hours. This condition indicates that the management should change their opinion about the mine being nongaseous and maintain an ample supply of air at the face at all times.

It is believed that many explosions that have occurred were due to the mine management being of the opinion that their property was non-gaseous or only made a "little" gas, and as a result they did not take the proper precautions to prevent a dangerous accumulation of methane.

The following is an analysis of a face sample of coal collected in a nearby mine at Bevier, Kentucky.

Lab. No.	Moisture	Vol. Matt.	Fix. Carbon	Ash	Sulphur	
3075	8,8	37+3	45.1	8,8	3.5	

Collected and analyses made by the U. S. Bureau of Mines in 1918.

ANALYSES COAL DUST SAMPLES

Analyses made as received. Samples collected by Mr. G. T. Powell of Evansville, Indiana, and Mr. A. U. Miller, Vincennes, Indiana, 12-20-28.

			Mois	Com-		To tal	S 121 ng	thru 20 thru	mesh
Lab.No.	Location	Kind	ture	bustible	Ash	Incomb.	48	100	200
47938	On 4th N. entry 150 ⁺ outby 5thWest	Roof & Rib	6.4	73.7	19.9	26.3	92.8	85.1	75.5
47936	Ditto above	Road	6.3	68.4	25.3	31.6	67.4	49.0	36. 8
47935	On 6th N Entry 150' inby 4th West	Roof & Rid	25,4	61.6	13.0	38.4	90.7	80.7	71.4
47937	Ditto above	Road	10.0	73.1	16.9	26.9	70.9	48.0	29 .9

Analyses made January 2, 1929 by U. S. Bureau of Mines, Pittsburgh, Pennsylvania by H. M. Cooper, Analyst.

It is believed that the above samples are representative of the general condition of the workings visited during the investigation.

Tests made by the U.S. Bureau of Mines show that four of the principal factors governing the explosibility of coal dust are as follows: (1) volatile ratio; (2) total amount of incombustible matter (moisture and ash); (3) fineness of dust; (4) and the percentage of methane in the air.

A study of the above table shows that the total incombustible in the dust samples range from 26.3 per cent to 38.4 per cent and that

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from 29.9 per cent to 75.5 per cent of the dust passed through a 200 mesh screen. These analyses indicate that the dust in mine No. 2 contains only from 4.2 to 16.2 per cent more ash than what is shown in the face sample of coal that was collected in a nearby mine, and that under favorable conditions it would propagate an explosion with extreme violence.

The U. S. Bureau of Mines tests also show that the West to total combustible. Kentucky No. 9 bed which has a volatile ratio of about .48, requires about 60% total incombustible material to prevent propagation when no gas is present in the return air. For each per cent of methane in the return air it requires 10 per cent more incombustible material. Hence, in order to prevent the propagation of an explosion by coal dust the U. S. Bureau of Mines recommends that all passageways be rock-dusted as stated in the recommendations.

The names and occupations of those who were killed are as follows:

1. Cleve Boland, Machineman

2. James Sullivan, Night boss

3. Otho Davis, Company man

4. Leonard Epley, ditto

5. Vermont Nelson,

6. Roy Ezell. Shot firer

The coroner's jury rendered the following verdict: "That the men were killed due to an explosion of gas and coal dust".

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