1902.

NEW SOUTH WALES.

Legislative Council.

GRETA COLLIERY FIRE.

(REPORT OF THE COURT OF INVESTIGATION ON.)

Ordered by the Council to be printed, 7 August, 1902.

Report of the Court of Investigation, Greta Colliery Fire.

C. G. WADE, Esq., Barrister-at-Law, Commissioner.

C. G. Wade, Esq., Barrister-at-Law, to The Honorable the Secretary for Mines.

Sir,

I received an appointment dated the 11th day of December, 1900, under the hand of the Secretary for Mines, Mr. Fegan, to hold an investigation (under the provisions of section 23 of the Coal Mines Regulation Act, 1896) into the cause of the fire which broke out at Greta Colliery on the 5th December, 1900, and resulted in the loss of five lives.

The Court of Investigation was duly opened at Greta on the 14th day of December. The following persons appeared before me, representing the various interests, viz.:—Mr. Curley, Secretary of the Colliery Employees' Federation, appearing on behalf of that Federation, and also for some of the relatives of the deceased; Mr. Atkinson, Chief Inspector of Coal-mines, appearing to watch the proceedings in the interests of the Mines Department; and Mr. Thompson, appearing for the Greta Colliery.

Evidence was taken on five days, and twenty-eight witnesses were examined. Owing to unavoidable circumstances, the pit had been sealed down on 10th December, before any definite information could be obtained as to the cause or extent of the fire; and as I had on 20th December taken all the evidence available, I then adjourned the inquiry until such time as the colliery might be unsealed, and further evidence procured relating to the cause of the outbreak.

The inquiry was not resumed until the 8th July, 1902. The scene of the fire had been examined in the meantime, and two bodies of the victims had been recovered. The Court sat on 8th, 9th, and 10th July, when four witnesses were recalled, and four new witnesses were examined. It appeared that the outbreak of a fire from spontaneous combustion during exploration operations necessitated the pit being sealed down in March last, and it has not yet been reopened. The dead bodies of three men are still unrecovered. Inasmuch, however, as it seemed most improbable that any further adjournment would throw any new light on the matter, I closed the inquiry on 10th July, and after consideration of the evidence and exhibits, I now have the honor to submit my report under the following heads:—

(1.) Description of the mine and method of working.
(2.) State of the mine, just before the fire was discovered.
(3.) Discovery of the fire, and steps taken to deal with it, and explore the mine.
(4.) Effects of the fire.
(5.) Cause of the fire.
(6.) Provisions against the recurrence of gob-fires.
(7.) Breaches of the Coal Mines Regulation Act and Special Rules.
(8.) Conclusion.

(1.) Description of the Mine and method of working.

The Greta Colliery is situated on the Great Northern Railway, some 32 miles from Newcastle, and has been worked for a number of years. The down-cast shaft is 425 feet deep, and the up-cast and fan-drift is some half mile distant. There is also a tunnel entrance 36 chains from the down-cast shaft which affords access to the pit bottom and other parts under ground. The tunnel is used as a travelling road, and the door, although kept shut by the air pressure, can be readily opened. The coal is of a bituminous, or semi-bituminous, nature. The seam is worked in two portions. The first part is some 9 feet in thickness; immediately after that is worked the tops are taken out, which are about 4 ft. 6 in. in thickness. In these tops is a band of material called "brassy tops," and iron pyrites is a constituent of these brassy tops. The roof of the colliery is conglomerate. At some time anterior to the occasion when the fire broke out—in December, 1900,—the districts on the north and west of the down-cast shaft had been largely worked, and were then practically abandoned. A large area, again, on the east and south of

Nature of seam.

Brassy tops.

Recurrence of gob fires.

the main south level had also been worked out in a similar manner. It appeared that from time to time, within recent years, no less than seven gob-fires had broken out. Six of these originated in the same locality—viz., to the south of the big jig—and one on the opposite side of the mine—viz., on the north side of the down-cast pit. This last, however, was owing to a workman's carelessness, and was not a true gob-fire. However, they all occurred in the old workings, but were of small dimensions, and were discovered at an early stage, and successfully dealt with, without any loss of life. The region of these fires has since been sealed off from the rest of the pit, and no trouble has been experienced from them since that operation was completed. In 1900 the work of coal-getting was carried on along the main slant and main south level; the former ran with a fall inwards, and was used as a main intake for the working districts in-bye. To the right were the old Nos. 2 and 3 levels, which had been worked out. These workings were on the dip, and were bounded—speaking roughly—on the west by the water, and on the east by the main slant. The method of working the bords in these old districts had been to take the coal, leaving the brassy tops standing, and throw the gob back into the working places; from time to time the brassy tops fell from the roof, and during the process of decomposition and disintegration emitted a peculiarly sulphurous smell. These old workings were kept sweet by allowing the air from the main slant in-take to scale through the door opposite the old No. 3 level, and gradually diffuse itself throughout those districts before returning to the surface. The workings just referred to had been abandoned for several years. According to the evidence, they are periodically inspected, but there has been no indication hitherto of trouble from gob-fires, as in the old south workings to the south of the big jig, where fires did break out. Returning now to the main slant, what is known as No. 2½ level branched off to the left, and there was a separate ventilating split for this district, and air travelled No. 2½ and No. 2 sections. Going further in-bye at the end of the main slant, No. 5 level branched off to the left, and No. 4 to the right, of the main in-take. The return air from these districts, before reaching the upcast shaft, is diffused through all old workings that are unsealed. The amount of air that was measured on the morning of the fire as entering 2½ split was 24,000 feet per minute; in No. 4 split, 5,390 feet; and in No. 5, 8,250 feet.

The main slant.

Old workings.

Method of coal-getting.

Ventilation of old workings.

No. 2½ level.

No. 5 level.

No. 4 level.

State of the roof.

It becomes necessary, inasmuch as the origin of the fire was located in the neighbourhood of the junction of No. 2 level with the main slant, to say something about the condition of the roofs and roadways in this locality. The main slant seems to have possessed a very good roof, and but little timber was necessary by way of support. In No. 2 flat, which is only a few yards off the main slant, the brassy tops were standing, and at a distance of about 1 chain from the turn was the over-cast, made of wood and covered with canvas. At the angle made by the main slant and No. 2 level stood a wooden chock to support the roof, which at this point is necessarily wider than usual. The chock was built of ironbark—just the bare skeleton, no earth on it or inside it, and no bark on the timber. There was also a prop against the rib on the in-bye side of the chock. According to Mr. Jonathan Dixon, who was manager previously to Mr. Jeffries, the main slant had, some years ago, been graded from No. 2 level down to No. 2½ by the use of ashes from the surface, and brassy tops and other material from within the mine. The bulk of this material was in a finely divided state, in parts 5 feet deep, and by constant watering, the haulage of skips, and general traffic over it, it must have become very solid. In 1898, No. 2 flat had been dealt with in a similar manner; the full road there had been built up with black stone, brassy tops, and other refuse till it stood 2 or 3 feet higher than the empty. In this instance the rest of the bank was only one-half the width of the road; the wall was built up so that the air might have access from the side. Now this part had not shown any sign of heating since its construction.

Building up of main slant,

and No. 2 flat.

Old bords off main slant.

One other matter remains to be mentioned in connection with this main slant. Some years previously two bords had been worked from the dip side. In the course of working, the main slant had been broken into at an angle, thus making an opening something like 5 feet by 4 feet. One of these openings was just below No. 2 level, the other was almost opposite No. 2½ level. These had been worked in the usual manner, the gob being heaped up on one side; and the floor level would be some 5 feet below that of the main slant since the grading. The opening between the bord and the slant was covered by canvas.

Inflammable material on roadways.

Several witnesses deposed to pieces of brattice cloth and bagging lying about the vicinity of No. 2 flat, or opposite the turn into No. 2 level. Apart from these things, and the timber referred to, there was nothing inflammable in that part of the pit.

(2.) State of the mine just before the fire was discovered.

5th December, 1900.

On 5th December, and for some time previously, there were two shifts at work in the mine. The day shift went down about 7 a.m., and returned to the surface about 4 p.m. A number of miners went down the main slant on to No. 2 level *en route*. Others, again, would turn off at No. 2 level. The wheelers were engaged continuously during the shift in making up-sets on No. 2 flat, and the deputy, in course of his duty, examined that flat in the early morning before the day-shift commenced work; yet, with all these men moving backwards and forwards during the day, nobody, with the exception of two men whom I will refer to later on, noticed anything unusual in that locality.

State of No. 2 level.

Jones.

Between a quarter to 4 and 4·15 p.m. the deputy, Clement Jones, waited on the main slant opposite No. 2 level, and counted out on their way from work the men who were in the day shift.

Slater and North.

Two witnesses, named Slater and North, were employed on the day-shift, and remained below till half-past 5. They were engaged in picking up coal that had fallen off the skips into the main road between the top of the incline and No. 2 level. They actually put some skips they had filled inside No. 2 level. Slater says they were smoking; North says they were not; but I think the probability is that they were both smoking, and I assume that to be the fact. In the meantime, shortly after 4 o'clock, the night-shift had gone in to work. Five men had gone to work in the part known as "Bartlett's." They travelled down by the main south level, and by good fortune happened to cease work earlier than usual that night, arriving at the surface again before 10 o'clock, and before the alarm of fire was raised. These men were not in the vicinity of No. 2 level during their shift, and they may be dismissed from further consideration.

The five missing men.

The five men who are now missing went down the main slant to their work about 4 o'clock. Buck and Fuller proceeded some distance past No. 2 level to their bord, which was in No. 4 district, within 4 yards of the main slant. The brothers Crowell were working farther in-bye in the last bord of No. 5 back level. Hislop was the wheeler to these men. It may be mentioned that they all would receive the air that had passed down the main slant past No. 2.

The

The last persons who, as far as we know, saw these unfortunate men alive were Jackson and Walker. The latter had been wheeling on the day shift, but remained, under instructions, to bail out some water from No. 5 district. He saw all these men before he left for home at, as he says, about 7 o'clock. According to Mr. Jeffries, however, it must have been earlier, because he says he saw Walker on the surface at 6·45. However, Walker came up the main slant somewhere about 7 o'clock, and states that he left these five men all well at their places, and noticed nothing unusual as he passed No. 2 level. William Jackson, the night deputy, was also in company with these men for a few minutes shortly before 5 o'clock ; when he left them they were all stripped and ready for work. Jackson and Walker.

(3.) Discovery of the fire, and steps taken to deal with it and explore the mine.

Jackson went on with his work in other parts of the pit till about 10 o'clock. Nothing attracted his attention till then, when shortly after, he says, he happened to go down the slant dip, just past old No. 1. Then, to use his own words,—"I heard a loud noise, like the bursting of a pipe, in front of me, and the report, which was like the roar of wind, got louder as I advanced. I went further on and saw clouds of smoke. I might have been 9 or 10 yards off the points when I met the smoke, which was like coal smoke, and pretty thick. I heard terrible bumping and crackling, and like rolls of thunder in the distance, like something falling. I did not see any flame then. There was a current of air passing along about 2 feet from the floor ; it was fighting against the smoke. I put my light near the ground to try and see a way through ; but could not see any way. I went 2 or 3 yards further back up the slant, and put my light on the ground. I tried to crawl in among the smoke, with my head well to the ground. I repeated this twice ; but had to retreat on account of the smoke. . . . The smoke was coming from the No. 2 flat, on the left-hand side. The crackling I took to be wood ; the bumping to be coal bursting off the side. I was about 9 or 10 yards from the chock." Jackson sees the fire.

This was between 10·20 and 10·25 at night. He went up at once to alarm the manager. The manager, Joshua Jeffries, had already received the alarm from Woodhouse. It appears that Woodhouse, the fanman, had noticed about 10·30 a slight mist in the fan-drift. At ten minutes past 9 everything had seemed as usual there. Being at a loss to explain the phnenomenon, he consulted a mate, Claxton. They jointly examined the smoke, which was growing thicker, and decided to report the matter ; and Woodhouse seems to have spoken to the manager only a very few minutes before Jackson arrived with his news from the mine. The manager immediately went down to the fan-drift. At that time, about ten minutes to 11, the smoke was pretty thick. Having satisfied himself of the serious position of affairs, he descended the shaft, and on examining the main south level over-cast, found smoke passing across very thickly. This showed the fire was in the main slant-dip workings. He shortly afterwards got down the main slant to a point within 50 yards of the fire, which was then burning strongly near No. 2 level ; but on account of the working of the roof and the thickness of the smoke, he was unable to get any closer by that road. Woodhouse notices the smoke at fan-drift.

We may now take the manager's version as to the steps taken to cope with the fire, and rescue the men. With a party of volunteers, which was promptly organised, efforts were made to get behind the fire by travelling the old workings on the dip side of the main slant. With this object in view, the air in this district was reversed, and the party travelled with it. Before they got abreast of the seat of the fire, however, they were driven back by the smoke. The air current was then increased, and another attempt was made along the same route. The party were in this way enabled to advance about 2 chains beyond their previous limit ; but the smoke eventually drove them back. The fan was then increased in speed, and two more attempts were made, with fruitless results. Eventually the ventilation was reversed, so as to make the main slant a return air-way, and in the hope of drawing the smoke away from that part ; but once more the party were doomed to failure. The farthest part the rescue party reached in-bye was 233 yards distant from Buck and Fuller's working-places. Chief Inspector Atkinson and Inspector Bates arrived at 9 o'clock. Another attempt was then made to reach the entombed men ; but the air was now full of noxious gases, and exploration was very dangerous. The Secretary for Mines, Mr. Fegan, and several colliery managers, arrived at 2·45, and after consultation it was decided to seal the pit down. This operation was finally accomplished on 10th December. Attempts to rescue the men. First attempt. Second attempt. Third and fourth attempts. Fifth attempt. Sixth attempt. Pit sealed down.

An attempt was made to resume operations in April, 1901. Although active flame had subsided, the heat was still very great. A heavy fall had taken place near No. 2 and the main slant. Owing to the great heat, and before anything practically could be accomplished in clearing the roadway, the action of the air, which was necessary for carrying on the work caused a fresh outbreak of flame, through playing on the mass ; accordingly the pit, after being open eleven days, was again sealed down. Pit unsealed, April, 1901. Sealed down again.

Another effort was made in January of this year, and work went on by continuous shifts until 1st March, when the fire that broke out last year caused the pit to be sealed down for the third time. During that period, however, the remains of Buck and Fuller were recovered. The other three are still in the colliery. Reopened January, 1902. Resealed March, 1902.

(4.) Effects of the fire.

The effect of the fire had been to cause heavy falls along the main slant, from a point 50 yards out-bye at No. 2 level to a point just beyond No. 2½ level ; a fall in No. 2 to a distance of 15 to 20 yards from the junction ; in No. 2½ for some 5 chains, and in both the old bords abutting on the main slant. The amount of roof and debris that was cleared away was about 8,000 tons, which was all removed before the resealing on 1st March. Extent of falls.

The action of flame was traced upon the coal over the same area as these falls, making a distance in all of 325 yards. Distillation of the coal had taken place under the intense heat from the point where the action of flame ceased out-bye of No. 2 level right back to the down-cast shaft, and in No. 2½ level in-bye, the last fall being right up to the working face. In No. 2 level the brassy-tops had fallen, but very little rock ; the chock, of course, had been consumed. Some of the skips on the empty road had been burned, and some of the full skips also. One thing noticeable was that on the left-hand side the pillar coal was coked, and some skips were burned on the side nearest that pillar only, as if the flame had attacked them from the rib side. No. 2 over-cast was intact ; also a pair of horse limbers and some empty skips which were under the over-cast. The stoppings in No. 2 flat were untouched. The chock at No. 2½ level was burnt out. In the old bords the heat had travelled inside some 15 yards, and penetrated down to the floor level. In these old bords stood heaped up material in places 12 feet deep, and extending in length for at least 15 yards, where brassy-tops had fallen owing to action of fire on the roof. Beyond a deposit of bountiful supplies of soot, the fire had produced no other effects than those above mentioned. Action of flame. In No. 2 level. In the old bords.

(5.) Cause of the fire.

Point of origin.

Every witness who offered an opinion located the origin of the fire at or near the turn into No. 2 level on the main slant. If that view is correct, then the flame would travel naturally with the intake towards No. 2½ level, and would be drawn by the slight draft into No. 2 level a short distance. In all probability then, whilst the air-current was reversed for three or four hours on the morning of 5th December, the flame advanced from No. 2 level for the space of 50 yards towards the shaft. Then once more when the ordinary air current was operating, before the sealing down on 5th December, the fire again advanced down the main slant, being drawn in to the other two bords, and eating its way to No. 2½ into which the greater volume of air would be passing.

Cause of the fire. Two theories, (1) Spontaneous combustion; (2) Naked light.

There still, however, remains the important question—what is the cause of the fire. Two theories are advanced—1st, that the origin was spontaneous combustion; 2nd, that it was a naked light. If that was the true cause, was it intentional, or an accident? I propose to deal first with the theory of spontaneous combustion. To appreciate the bearing of this theory upon the established facts in this inquiry it is necessary to consider what is the scientific explanation of gob-fires.

Causes of spontaneous combustion.

Generally speaking, three factors are assigned as contributing to gob-fires. (*a*) Oxidation of the organic constituents of the coal. (*b*) Iron pyrites. (*c*) Pressure. Whether these are all contributing causes or not remains to be seen.

(*a*) Oxidation of coal.

It is now well established that coal naturally absorbs oxygen from the air, and undergoes a process of slow combustion. As this process goes on, heat is developed, and every access of temperature tends to bring about the further absorption of oxygen. Thus the temperature of coal is raised, and if certain conditions are present the ignition point is eventually reached. There are two conditions under which heat will not be developed; 1st, if there is not a sufficient supply of oxygen, or if the coal is prevented from coming into contact with the air; 2nd, if that air supply is so ample as to carry away from time to time the heat which is generated. What is requisite to ignition is a nice adjustment of the above conditions, whereby the supply of oxygen is maintained, and the heat developed is continually being utilised to add to the temperature of the mass. When dealing with a heap of coal the absorption of oxygen is slow owing to the restricted area of surface on which the atmosphere can play, and such heat as is generated is easily carried away by the air current. On the other hand, if the coal is a mass of fine powder, the air cannot penetrate with sufficient freedom to allow of oxidation being set up to any extent; and the more closely it is packed the less opportunity there is for the air to penetrate. The best conditions to bring about the absorption of oxygen are when the coal is so small as to present the maximum of surface, and yet not so small as to prevent permeation by the atmosphere.

Influence of small coal.

Depth of coal.

The depth of the heap again has an important influence determining the liability to spontaneous combustion. Fayol, the great French chemist, states that with heaps of slack or Commentry coal no spontaneous combustion occurred in heaps less than 2 metres high; yet it almost invariably occurred when the heap measured more than 4 metres high.

(*b*) Iron pyrites.

The oxidation of the carboniferous constituents of coal is pretty well established; but it becomes desirable to ascertain, inasmuch as iron pyrites are present in the brassy tops of the Greta seam, whether they are a contributing cause to spontaneous combustion either directly or indirectly.

Until lately, mining experts held the opinion that iron pyrites were a very important factor in spontaneous heating, and Dr. Haldane strongly supported that theory. No doubt the theory receives support from the fact that coal has ignited spontaneously when it was known that iron pyrites were present. In recent years, however, the subject has received the attention of the eminent Continental scientists, Fayol and Richter; and Professor Threlfall, who was a member of the Royal Commission appointed in Sydney in 1897 to inquire into the causes of coal cargoes taking fire, has also made a special study of the matter. Experiments have been conducted with coal free from iron pyrites, and with iron pyrites isolated from carbon constituents. Without going into any details as to the variety and number of experiments made, it will be sufficient to recapitulate some of the main conclusions arrived at by these gentlemen, and the views of prominent coal experts in England at the present day.

Opinion of Fayol and Richter.

Fayol and Richter come to the conclusion that the heat liberated by the oxidation of coal is much greater than the amount liberated by the oxidation of the same amount of iron pyrites; and that iron pyrites have little or no influence in bringing about spontaneous ignition.

Clarke and Hughes.

Messrs. Clarke and Hughes, in the paper read before the Federated Institute of Mining Engineers, vol. 3, page 45, laid down these propositions:—That the oxidation of iron pyrites is not the primary agent in producing combustion. They instance the sulphur coal of South Staffordshire, which contains a large amount of iron pyrites, and never fires spontaneously; and, moreover, that spontaneous combustion most frequently occurs in seams which are free from iron pyrites. Mr. Hayward again (vol. 17 of the same work, pages 2, 3, 5, and 6) says that he knew of a seam containing a large proportion of iron pyrites, in which, during a period of thirty years, he had not known of a gob-fire. Mr. Lewes, again, in a paper read before the Institute of Naval Architects (vol. 31, page 204), asserts his experience that some of the coals which are most prone to spontaneous combustion contain less than 1 per cent. of iron pyrites. Again, iron pyrites are largely used commercially, and when free from carbonaceous matter may be kept in almost a powdered state in large heaps of hundreds of tons; and although continually undergoing oxidation, there has never been found any rise of temperature that will approach the igniting point of coal.

Hayward.

Lewes.

It seems to be admitted that iron pyrites require water to help oxidation to any appreciable extent, yet there are many instances where coal has ignited spontaneously which was dry and even warm.

The Government Inspectors and the mine manager are of opinion that the disintegration of brassy tops by themselves is sufficient to produce fire if the heat is not carried off. No doubt brassy tops have been present in each of the gob-fires of late years, but as this issue was not discussed at any great length before me, I am not prepared on this evidence to express a decided opinion one way or the other.

Iron pyrites have indirect influence. Threlfall's views.

However, although it may not be that iron pyrites are direct yet they certainly seem to be an indirect cause in breaking up the coal into smaller fragments, and so incurring oxidation. Threlfall denies even this indirect influence so far as fires on board ship are concerned; but, in all cases referred to by him, the fire has started at the hatch where there was an abundance of small coal already, and the time has been too short to allow of iron pyrites having any effect.

Yet, on the other hand, conditions in a colliery are different. The brassy tops are down, perhaps, for years, and in the course of time a combination of brasses with oxygen causes a swelling of the oxidised matters, breaking up the coal; fresh surfaces are thus exposed, and the substance becomes more pervious to the action of the air.

Whether

Whether this disintegration is brought about in the absence of moisture is a point upon which authorities are not yet unanimous. There is no doubt that the operation does go on when moisture is added.

(c) The part played by pressure again is of an indirect nature. The crushing of pillars does not in itself produce any appreciable increase of heat, and certainly not enough to bring about spontaneous combustion. Pressure, however, has an indirect influence, inasmuch as it causes the coal to be ground to a very small dust, which tends to its more rapid oxidation. (c) Pressure.

One thus returns to the original starting point, that oxidation of the organic constituents of the coal is the principal, if not the only direct cause, of the gob-fires. That combustion can be brought about spontaneously, whether iron pyrites are present or not, and irrespective also of great pressure, is admitted; yet the latter may be indirectly a contributory agency.

Applying, then, these conclusions to the present fire, pressure is a factor which advances the position very materially. The evidence of it along the flame-affected parts was very meagre. Beyond an occasional scaling of the roof and sides of No. 2 level, there was nothing. Indications of pressure in Bartlett's were frequent, but this section was too far away to affect the area of the fire.

There are, moreover, some general characteristics of gob-fires which always serve as a warning to miners. (1) In the first place, the growth is gradual. The incubating period is some days, at times even weeks, and during that period there is a gradual increase of temperature that is noticeable. (2) As the coal distills from the excessive heat, fire-stink or gob-stink is emitted, a smell that is noticeable and unmistakable by a person who has smelt it before, and (3) lastly, a mist is generated and given off. These are concomitants of every gob-fire, and it is remarkable that every fire at Greta previously was discovered either by the man in the up cast shaft or an official in the mine recognising this odour or gob-stink. Now, none of these conditions were noticed near the area of this fire before or on 5th December. To the wheelers, who were in and about No. 2 level all day long, and many others passing to and fro, the heat, if present, would surely be manifest, especially when we bear in mind that coal, to break into flame spontaneously, requires a temperature from 600 to 800 degrees. No smoke was seen in the fan-drift till 10·30, and at that time Jackson had just discovered the actual flame. Moreover, every previous gob-fire originated in the old workings, and there had been no gob-fire of any kind on the out-bye side of the main slant.

General characteristics of gob-fire. (1) Gradual growth. (2) Fire-stink. (3) Smoke. All absent in present case.

The only evidence that can be said to directly point to spontaneous combustion is that of the miners Teasey and Byers. These two men were going to work together down the main slant at 7 a.m. on the 5th. Teasey says that opposite the door of old No. 3, he noticed a stink that came from a fire, and drew Byers' attention to it. This witness was most unsatisfactory, and upon examination he stated that he knew the smell of gob-fire; that this was the same; yet he makes the astounding statement that he thought there was no danger, and never gave it a thought again; and that, although the deputy called at his working place during the shift, he never thought of mentioning it.

Evidence of Teasey and Byers.

Byers, his mate, admits he noticed nothing until Teasey called his attention to it. He admits it was a strong sulphurous smell, but says he did not think it serious, and did not report it; but would have done so had he thought it was a gob-fire.

One admission, that both these men made, militates against the theory of gob-fire, viz., that when they passed the same spot in the evening there was no smell. That these men smelt something, I have no doubt. That it was not fire-stink I have no doubt. The door opposite the old No. 3 level gave access to old workings. Other witnesses state that they have at different times detected at that spot the sulphury smell of decomposed brassy tops. The explanation may be that Teasey did meet the same smell, and in the excitement of hearing about the fire so soon after, he imagined, in all good faith, that that smell was really fire-stink. A man who has actually smelt true fire-stink will not mistake it again; and if fire-stink were present in the morning, it must have been there in the evening, and must have pervaded the mine during all that time. In addition to this, the increase of heat must have been apparent to all in the neighbourhood.

So far it has been proved that general indications of an incubating gob-fire were absent on this day. It was further suggested that the conditions existing in the main slant between Nos. 2 and 2½ levels, and in No. 2 flat, were favourable to the development of gob-fire; that inasmuch as the road had been raised in each place by the use of brassy tops, and had been constantly watered, there was every element necessary to generate heat unless the air was sufficient to dissipate it.

Was gob-fire favoured by conditions in— (1) main slant; (2) or No. 2 level;

The first and most convincing answer to this theory is that not one man of all those passing the spots daily noticed the least indication of heating smoke or fire-stink before the outbreak; and during all the operations this year, after material had been lying burning on the main slant roadway for a considerable time, there was only one spot, as far as could be ascertained, which was at all heated beneath the surface. Where this heated material had been dug out a hole was left some 3 feet in diameter and a few feet in depth. This condition was attributed to the burning roof having fallen on the road in consequence of the original fire. Moreover, the probable effect of watering the made-up road would be, in consequence of continual traffic of men and vehicles during something like four years, to make the road absolutely solid and almost impervious to air underneath the surface; or, if the air had access, then not too such an extent as to be in the least dangerous. The last suggestion was that a gob-fire may have developed in either of the old bords abutting on the main slant. Undoubtedly, when the exploration began, there was found in each bord a heated mass, 15 yards long and 8 or 9 feet in depth; but, clearly, fire could not have originated in the bord just below 2½ level owing to (1) the course the fire took, and (2) the conditions of the bord itself.

(3) or of the old bords?

As to (1) we have seen that the whole course of the flame in the main slant was for 150 yards on the down-cast shaft side of this old bord and only a very short distance on the in-bye side of the same bord. From the time when the fire was first discovered on the 5th till the pit was sealed down on the 10th December, the air current had been (excepting a period of three or four hours, when it was reversed) from the downcast towards the bord; and if we are to fix the latter as the point of origin, then the flame must have travelled 150 yards against an air current of some 500 feet velocity per minute.

(2.) Nor can it be the bord near No. 2 level, because only one side of the bord had been charred. The probable explanation of flame being found in these two bords is that the fire, when spreading down the main slant, burned the canvas stoppings over these two bord ends, and, being drawn in by the slight current of air, just licked the side of the place for a short distance; at the same time producing sufficient heat to cause the roof and pillar side to fall.

This

This explanation accords with the evidence of the manager as to the condition of these two bords previously. In each instance the bord had been worked as far as the white stone, which runs about midway through the seam. The upper part of the seam with the brassy tops being left overhead there was the usual gob on the floor which was not liable to spontaneous combustion. The large depth of coal and roof which was removed from these bords fell through the action of flame and heat produced by the fire in the main slant. Now, these places being visited during the previous week, nothing was noticed of an unusual nature.

Theory of gob fire unsupported.

I have now dealt with all the possible ways by which this fire could be attributed to spontaneous combustion, and I am of opinion, without any doubt, that such a theory is negatived by the evidence and probabilities.

Naked light theory. Was it accidental?

If, then, the fire was caused by a spark or naked light, at what time was the light applied? What are the possibilities and the times when a spark may have fallen accidentally? It appears that the day-shift men are all out of the pit by half-past four. Jones and Humphries, the deputies, were opposite No. 2 for half an hour counting all the men out from work, and sitting within 5 yards of the chock at No. 2 level they saw nothing in the way of flame or light. It is most improbable that if there was material smouldering within 5 yards of these men neither of them, with his opportunities of observation, would see it. At a quarter-past four Jones leaves the pit. Slater and North were there for the next hour. They were probably both smoking, and Slater admits that he trimmed his lamp near No. 2 level about 5 o'clock; but at 5·30 they are gone, and they say they saw no sign of fire. If one of these men dropped a spark then it must have been smouldering in this main current for nearly five hours. Jackson, a deputy, passed by this same spot just as North and Slater were knocking off work, and he saw nothing. The last, as far as we know, to pass that level was Walker, the water-baler. He, again, says he saw nothing, and that he did not stop anywhere on his way out. Even if a spark were dropped as late as 7 o'clock, then could it be slowly gathering strength for fully three hours before any indication was noticed that a fire was in existence?

I am unable to adopt the theory that the initial spark fell at any time before 7 p.m., because (1) to keep it alive in the air current it must have fallen upon something inflammable, and if it fell upon something inflammable then the current must have fanned that into a flame in a short period of time. Thus the fire would be gradually growing and giving off smoke long before the hour when Jackson discovered it. (2) The air and smoke would reach Buck and Fuller in less than 400 yards distance after leaving No. 2 level, and the Crowells again shortly after. They would then naturally take alarm and leave the working face in a hurry. (3) The smoke following the air current round the workings would subsequently manifest itself at the fan shaft either to the nose or to the eyes.

Fire grew suddenly.

Now, everything points to this being a fire that grew suddenly and rapidly. When Buck and Fuller were last seen by Jackson, at 5 o'clock, they were stripped and starting to work. When their bodies were found they appeared to be fully dressed, and their tucker-tins were found close by. Moreover, Buck was in the habit of knocking off work just about 10 o'clock. Everything betokened a leisurely exit, and the inference from it is that when they left this working they had not received the alarm of fire, and, in accordance with medical evidence, they must have been overcome by the smoke and died from suffocation where they were found. In addition to this, Jackson finds the fire burning strongly a little after 10 o'clock, and about 10·30 the man at the fan-drift notices for the first time a faint mist which soon developed into an unmistakable smoke.

Probably lighted about 10 p.m.

Was the fire wilful?

Assuming then that the fire was originated shortly after 10 o'clock, and by human agency, either directly or indirectly, the most difficult question remaining is whether the act was intentionial or not. I should be very loth to answer that question in the affirmative without the clearest proof. But there are difficulties in the way. In the first place, there is no clue as to the identity of the person who started the fire. One cannot say whether Crowell or Hislop had been in No. 2 level, or even Buck or Fuller themselves. Again, if this was a criminal act, the criminal could have access to the pit, without being seen, by the tunnel only. He must, moreover, have had a knowledge of the pit and the roads; and if he travelled a circuitous route to avoid being seen, the nearest way to No. 2 level would take half an hour's walking both to and fro. Then, again, if the man had a knowledge of the habits of the pit, he must also have known that these unhappy men were at work there, and that his act would probably mean the death of them all.

Under such circumstances, a motive is sought for naturally. The evidence offered of motive is very remote, and adds little or no weight to the inferences from the main facts. Mr. Jeffries says that some few weeks before the fire broke out a statement was made to him that somebody had stated that damage would be done to the mine. As a matter of precaution he had a constable of police watching the tunnel mouth for several nights. At the end of that time, nothing having taken place, and thinking the danger was over, he withdrew the constable. It will be noticed that this intimation filtered through a third party, a fact which detracts from its value; and Jeffries himself admitted that there was no ill-feeling that he knew of between the management and any of the men. No doubt the circumstances give rise to very strong suspicion, but I cannot see my way to make the positive statement that the facts are inconsistent with any other conclusion than that of arson.

No positive proof.

(6.) Provision against recurrence of gob-fires.

The third resealing of the pit was owing, according to the evidence, to a gob-fire. Mr. Dixon is of opinion that it was the outcome of the original fire. The conditions were such that the heat which passed into the mass on the main road was unable to escape. Mr. Jeffries thinks it was caused by the unsealing of the pit, and not by any heat from the original fire. The difference of opinion, after all, may not be of any consequence; but if Jeffries is correct, then he corroborates the statement of Dixon that the Greta Colliery is liable to gob-fires. It, therefore, becomes important to consider what precautions should be taken to prevent these outbreaks. Mr. Dixon's evidence on this point is very valuable. He was for a number of years the colliery manager, and took part in subduing every previous fire in the pit. His analysis of the cause of the ignition in each case is as follows:—

Previous gob-fires.

The solitary fire at the north side was owing to a workman's carelessness. Of the six on the south side, one was at the foot of a pillar, and was probably caused by the heated air from an active fire 100 yards away playing on coal at that spot. As to the remaining five, in each instance brassy tops were down,

down, and in four cases they were covered by a layer of shaly sandstone. The brassy tops and sandstone co-existed also in the last fire in February of this year. He and Mr. Atkinson both stated that they observed in parts of the mine a layer of shaly sandstone from 1 to 2 feet in thickness, and interposed between the brassy tops and the conglomerate roof. This was noticeable in patches at the back of the down-cast shaft, but more marked in the main south, where these gob-fires were located. The effect of this superincumbent sandstone is that, whilst admitting the air to allow of oxidation of the brassies, the heat is confined, and cannot get away until the ignition point is reached. Whilst unable to explain the fifth fire, where the brassy tops were not so covered, Dixon still argues that this blanketing of sandstone set up the conditions necessary in all the other cases. He further states that there were acres of brassy tops fallen in the colliery, and where there is a fair current of air, and no sandstone overlying, there has been no trouble at any time. Whether the iron pyrites were a direct or indirect factor I have dealt with already; but I may take it as proved that they tend to increase the surface area that may be heated, and that the sandstone is a further element—that is, to conditions unusually favourable to spontaneous combustion.

Brassy tops blanketed by sandstone.

What, then, should be done by way of prevention in future? Generally speaking, it seems to be now admitted that the old idea of excluding air from the workings containing brassy tops is exploded. Experience has shown that the best protection is a current of air to dissipate any development of heat. In the next place all timber, brattice, and other inflammable material should be removed from old workings, and no small coal should be left lying about. So much for the actual condition of the workings. If these measures are adopted, there does not seem to be any danger from brassy tops alone lying in the old workings. Added risk may come from blanketing the brassy tops, either from this sandstone, or any large superincumbent mass of stone. To meet such a contingency, all the workings should be inspected periodically, and written report made as to the state of the same; and this duty of inspection should be enforced under a penalty. There seems to be nothing under the special rules of this colliery on this matter. I think that a rule providing for such inspection should be added to the colliery rules now in existence. Special attention should be given to the blanketing of brassy tops. It may not be necessary to remove them at once; but if they are not removed, the spot should be watched for any sign of increased heat. A further protection will be afforded by the observation of a man at the fan shaft, who should make frequent inspections of the air in the drift, and report anything unusual. With the adoption of these precautions, and a careful watch on the part of all men employed, the danger from gob-fires is small.

Prevention in future.

By ventilation.

Removal of inflammable material and small coal.

Frequent inspections.

And observation at fan shaft.

In conclusion, I am glad to say that the care in this respect seems to have been exercised in the past, and these fires have always been taken in time.

(7.) Breach of Coal Mines Regulation Act and Special Rules.

After the first sealing down of the pit in December, 1900, at the request of the Honorable the Secretary for Mines, I made an interim report dealing with the breaches of the Coal Mines Regulation Act and Special Rules. I now beg to add the following extracts from that report:—

"There has been, in my opinion, a breach of section 47, General Rule 4, as to inspection of working-places. The practice at Greta Colliery lately has been to work in two continuous shifts; the day-shift commences at 7 a.m., and ends at 4 p.m.; the night-shift goes down at 4 p.m., and works on until midnight. A proper inspection is made of all the working-places, in accordance with the Special Rules and the Act, prior to the day-shift commencing work, and the inspection is recorded in a book in compliance with General Rule 4, subsection 1. In the course of the day-shift, an inspection is again made of those parts where the workmen are to pass during the shift. It appears that there are at least two working-places which were occupied by the night-shift, but which were idle during the day-shift. These places were also inspected during the course of the day-shift; but no written report was made of such inspection; and therein lies the breach of the Act.

Breach of G.R. 4, section 47.

General Rule 4 provides for inspection (within a certain time prior to the commencement of each shift) of those parts of the mine where workmen are to pass during that shift. The result of that inspection must be entered in a book which shall be exhibited to the workmen. This provision for recording the inspection is evidently for the purpose of allowing the workmen to know the condition of the places in which they are called upon to travel. The concluding part of the rule says that 'when two shifts succeed one another without any interval they are to be deemed for the foregoing purpose—that is, making the entry in the book—to be one shift.'

Subsection 2 of the same rule provides that "Although one written report only is necessary in the case of two successive shifts, yet another inspection must be made during each shift.'

The manager of Greta Colliery is under the impression that, because there were two successive shifts, if an inspection is made before the commencement of the first shift, and that is recorded in the book, an inspection before the second shift need not be so recorded, although the working places are different from those in the first shift. In my opinion, the Act only dispenses with a written report after the second inspection in those cases where the same working places are occupied in both shifts. It is not the continuity of shifts that allows the exemption from a written report, but the identity of working places. If the day-shift work at (say) bords 1 to 15, and the night-shift succeeding them without an interval work at bords 16 to 30, it would follow that under the system at present pursued at Greta there need not be any record of the inspection prior to the commencement of the night-shift; and thus the workman loses the right of examining the report to which he is entitled by statute. Although there are only two new working places, in the present instance the principle involved is the same, that whenever, in the case of continuous shifts, a place or places are to be worked in during the second shift which were not occupied during the first shift, the result of the inspection of these new places must be recorded in the book kept for that purpose.

But although the manager and the inspecting deputy are technically liable to a prosecution for this breach of General Rule 4, I do not think such a course would be advisable, for these reasons:—

(1) The section is by no means clear, and a layman might very easily make the same mistake in interpretation as Mr. Jeffries.

(2) No substantial wrong has been done; because, as a matter of fact, the working places always have been inspected before the workmen went in.

(3) The above reasons would weigh strongly with the magistrate, and the penalty imposed would most likely be the lowest possible.

Mr.

Mr. Jeffries seems to be a careful manager, and an intimation to him as to the proper reading of the section, I think, would be acted upon.

Breach of Special Rule 70.

Two miners gave evidence, named Teasey and Byers. They stated that on going to work on the morning of the day when the fire broke out, and at a spot near where the fire was located, they noticed a sulphurous smell; the suggestion was that the smell was "gob-stink," and that the fire was a gob-fire. Had they really believed it was gob-stink they should certainly be prosecuted for not reporting the same under Special Rule 70; but each man gave his evidence in an unsatisfactory manner—one was evidently ill, and the other, whatever the reason may be, seemed very confused and stupid, and, when pressed, each man said that he did not consider that there was anything in the smell to cause alarm. I think, therefore, a prosecution would fail.

With these exceptions, the management and discipline of the colliery seemed to be satisfactory."

(8.) Conclusions.

I find—

1. That the fire was caused by a naked light, and was not the result of spontaneous combustion.
2. That the fire was suddenly developed.
3. That there is not sufficient evidence justifying me in saying that it was intentionally lighted.
4. That the five men who were entombed died from suffocation.
5. That the Greta Colliery is liable to outbreaks of gob-fires.
6. That the conditions are favourable to gob-fires when brassy tops are covered with sandstone from the roof.
7. That the outbreak of gob-fires can be anticipated by careful inspection, and removal of all timber and small coal from the workings.

I have the honor to be,
Sir,
Your obedient Servant,

C. G. WADE, J.P.,
Commissioner.

Sydney, 21st July, 1902.

Sydney: William Applegate Gullick, Government Printer.—1902.

[6d.]