Miners' Lamp Committee.—At the present moment there is, sitting in London, a Committee to inquire into the improvement of the miners' lamp. Let us assume for the moment that they will decide that, although the lamps of the present day show great improvement, the standard reached is not sufficient for them to recommend the general introduction of any one lamp. What will they do? Will they leave the future of the lamp in the hands of manufacturers, laying down a standard to be aimed at, or will they throw the onus on the coal industry? This brings up the question of research and the advisability or otherwise of apportioning a sum of money for this end.

I hope it will be the privilege of this meeting, which Mr. Gaster has striven to make as representative as possible, after pointing out the urgent need for increased illumination in our coal mines, to indicate the methods for obtaining this end. I myself am full of hope, as the coalowners, who, as a class, have always the best interest of their employees at heart, now realise the importance of the question. I think that in this twentieth year of the twentieth century the long continued supremacy of the farthing dip will be finally ended.

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b—ILLUMINATION IN COAL MINES—SOME OBSERVATIONS

By H. S. ELWORTHY, F.R.C.S.

EBBW VALE, MON.

To illuminate coal mines satisfactorily, what is required is a safety lamp that will give sufficient light, and of a suitable quality to enable the miner to work without getting the disease known as miners' nystagmus.

This is a disease of the nervous system, and not one of the eye only.

As mines become older, and the coal further away from the fresh air shaft, the air becomes more deoxydised, and oil lamps give less

light. It must not be forgotten that if the air is so bad that a lamp will not burn properly, it is bad for the man to work in it, and simply to provide a better light and leave him to work in bad air is not a complete remedy—it is only a partial one. The conditions in coal mines are different from those in any other occupation.

The colour of coal is nearly black, containing from $2\frac{1}{2}$ to $3\frac{1}{2}$ per cent. of white, and the slack is sometimes as black, but more often slightly lighter.

The colour relief is the average of these taken together. Here is a card showing the colour of one of our pits; it contains between $2\frac{1}{2}$ and 3 per cent. of white.

I will give three examples of conditions found in steam coal pits:

	Candle-power of lamp.	Colour relief.	Surface brightness.	Distance lamps apart.
Pit 1	0.1	2.7	0.00058	15 ft. 6 in.
Pit 2	0.19	2.55	0.00055	18 ft.
Pit 3	0.12	3.3	0.0004	8 ft. 6 in.

Here men work in surroundings with only 3 per cent. of colour, or less, with lamps from 8 to 15 feet apart, giving from 0.1 to 0.2 candle-power, and where the coal only reflects from half a thousandth to a four-thousandth part of a foot-candle, and that light appears as small glistening white or bluish-white specks. No red or yellow is seen. The roof in some places is black and glassy, and is faintly radioactive. Here is a photograph taken by placing lead letters on a plate, and the piece of roof resting on them.

If a man works 20 years with his head close under such a roof, it is just possible that it may have some effect on his nervous system, but I rather doubt it.

Concerning nystagmus, a paper of mine was published in the *British Medical Journal* for November 19, 1910, in which I suggested that more colour should be introduced into mines, and that the men should have more daylight; and in another paper, which appeared in the *Ophthalmoscope* for December, 1912, it was shown in the reprint that the incidence of nystagmus was inversely proportional to the chromophotic index of the mine, and that I had found no nystagmus when this index was as high as 500.

The chromophotic index is made up of three factors—the candle-power of the lamp, the surface brightness of the coal, and the colour relief. We cannot alter the surface brightness to any extent, but we can alter the colour relief by passing the posts through a light

wash, or by colouring the roof, and we can alter the candle-power either by improving the ventilation or by introducing electric lamps.

So far colliery owners do not seem to fancy introducing colour, and problems of ventilation are very difficult, so they prefer to increase the candle-power of the lamps.

In the Ebbw Vale collieries for the years 1909, 1910, and 1911 our percentage of nystagmus among underground workers was 0·71, the general percentage for South Wales was 0·17, and for the Anthracite Field, 0·019, so we had four times as much as the average for South Wales. Since then certain changes have been made.

A new fan was put into one mine, haulage engines are now worked by compressed air, so more gets into the mines.

Electric lamps were introduced in 1914, first the C.E.A.G., and these have now been replaced by the Oldham lamp. We have over 6,000 of them now.

In 1914 we had 0·73 of nystagmus, and the next year it had dropped to 0·22. Then the war came and "summer time" was introduced, and then shorter hours, so the men got more daylight.

A number of our colliers went to the war, and their places were taken by new men who would not be likely to get nystagmus for years.

For last year, 1919, our percentage had dropped to 0·1, the general rate for South Wales was 0·28, and for the Anthracite Field 0·16, so we had less than half the average.

In looking over my papers for 1913 I find two calculations to determine the minimum candle-power required to bring two of our worst pits up to the safety margin, that is to say, a chromophotic index of 500, and in both cases the candle-power required was 0·9.

This coincides very closely with Dr. Llewellyn's results, as he suggests that it should be one candle-power.

But let me make it quite clear that when I say a miner's lamp should be one candle-power, I mean that the light that passes through the thick outer glass is fully equal to a standard candle. I certainly do not mean that the little electric bulb may give one candle-power, but when the outer glass is put on, the light is a good deal less. To call such a lamp one candle-power is misleading.

Now, as to the quality of the light. With an oil lamp, one sees a rich yellow light with a tinge of red in it when in fresh air, but on arriving at the coal face, where the candle-power has become reduced, say from 0·5 to 0·1, a very noticeable change is to be seen. Although the flame is practically the same size, it has become distinctly paler. Part of the red and yellow rays have disappeared, and the flame looks pale bluish-white. On returning to the surface the yellow and red appear again. In places where the coal reflected a large proportion of blue, with this pale bluish light, I noticed a sensation of strain and discomfort in the eyes, but in places where

the coal did not reflect much blue it was not noticed. In one of these bluish pits where the roof had been whitewashed for experiment, I and others noticed a distinct sense of relief to the eyes when passing under it.

The light that affects the eye of a miner is that which is reflected into it from the coal. That is the important point.

Experiments

In order to find out what rays were most irritating to the eyes, I got some light filters which roughly divide the spectrum into three equal parts, red, green, and blue.

With a small lamp in a dark box, a ray of light was passed through these filters, through an aperture 1 mm. in diameter, thus showing a small spot of light in a dark room.

Thirty people were tested by these lights.

After looking at the spot of light for a short time, the visual purple in the retina where the light falls on it becomes exhausted, and the eyes unconsciously move in order to focus it on other parts of the retina and so enable it to be seen, and this is what happens in nystagmus.

These experiments led me to conclude that the red and green caused the most active movements, but in the case of the blue the spot of light quickly disappeared, to reappear and disappear again. It seemed to exhaust the visual purple more than the other colours, but caused less active movements.

If, however, all red rays were excluded by using a blue-green glass, or a methyl-violet filter, the movements were active, but the tendency to disappear remained.

In the case of a man who was rather subject to watery eyes, the effect was remarkable. The red and green gave the ordinary movements, but no trouble; but the blue brought on profuse lacrymation, and after about five minutes his lids were swollen up, and he looked as if he were suffering from a severe cold.

Another man experienced smarting in the eyes when methyl-violet was used.

It seems to me evident that the rays from the violet end of the spectrum—which may include ultra-violet rays—have an exhausting and irritating effect on the eye, and an excess of them is to be carefully avoided in any lamp used in a mine.

In cases of incurable nystagmus I have known men to suffer severe pain in the eyes and head for years after they had left work, and the pain often came on at night, when they were not using the eyes, so they got up and tramped about the house because they could not sleep for pain. This did not seem to be due to errors of refraction, because supplying new spectacles did not cure it.

The condition must surely be brought about by something other than the mere working in a defective light. It seems suggestive of something in the nature of an X-ray or ultra-violet burn, and I have a strong suspicion that there is a distinct relationship between incurable nystagmus and the rays from the violet end of the spectrum.

In my series of 200 cases, there were 10 incurable, and eight out of these worked in pits where the light was pale and the coal reflected a large proportion of blue.

By using these light filters, and a corresponding filter over the eyepiece of a photometer, it is possible for a sensitive eye to make a rough analysis of various lights, and of the light reflected from different sorts of coal.

To give a few examples :

	Blue %	Green %	Red %
Tallow candle	5.53	28.84	67.63
Marsaut oil lamp	7.2	22.2	70.6
Carbon filament electric	6.64	26.63	66.63
C.E.A.G. electric	13.63	31.13	55.24
Oldham electric	—	—	—

Here you see the metallic filament lamp gives out twice as much blue as the carbon, or tallow candle.

Light reflected from coals :

	Blue %	Green %	Red %
House coal, Forest of Dean ...	4.5	13.3	82.1
Anthracite	4.7	23.9	71.4
Welsh steam coal	9.0	26.0	65.0
Ditto	9.12	33.43	57.45

Here you see the steam coal reflects twice as much blue as the anthracite or the house coal, and it is in the steam coal pits that we get the most nystagmus.

From these remarks it might appear that the problem of miners' nystagmus is comparatively simple, but to me it is exceedingly complicated and puzzling. My observations have been few, and confined to one locality, and it would be unwise to generalize from them unless confirmed by others.

Only once have I noticed an oil lamp look yellow at the coal face, and then the conditions were probably abnormal. The intake

airway was partially flooded that day, so we had to go in by the air exit. While going in there was a fall of roof partially blocking the way, but a few hours before there had been a fall just before the last working place was reached, completely blocking it up. By the time we got there a small passage had been made large enough for us to crawl through with my apparatus.

Here the flame of the lamp was distinctly yellow, and from its appearance I judged it to be 0.4 or 0.5 c.p., but on measuring it found it was only 0.12. Yet the flame was not small.

On analysis it was found to contain blue 5.2, green 21.4, red 73.4, which is very much what it would have been on the surface. As you know, if a small oil lamp is turned down till it gives only say 0.2 cp., it looks bluish. Such a flame gave on analysis: blue 9.5, green 26.9, red 63.6, so that an explanation of the yellow flame seen in the mine can only be arrived at by knowing the composition of the air. In other parts of that pit the flame was pale. The presence of certain gases may have something to do with nystagmus. Much research is required before we can profess to know all about it, and very great care should be taken in illuminating, lest a light be introduced which for a time seems beneficial, but which in the course of years may easily result in a greatly increased output of nystagmus of an incurable type.

We have found that the cost of running the C.E.A.G. lamp runs out at about—taking the whole of the costs from the beginning, for the last six years—1.29d. per shift, which we regard as a very reasonable figure, seeing that it was much lower in the first years, as the cost of labour and materials has latterly gone up considerably.

If you gentlemen were called in to improve the lighting of a room with a very dark and dingy paper, I think the first thing you would do would be to order a lighter one, that would reflect the light better. It is the same principle in coal mines. If, instead of working with a tenth of a candle power in coal, the men were working in chalk, there would be no nystagmus. They would have a better illumination, because chalk reflects, say, from 90 to 95 per cent. of light, but coal less than 9 per cent., so that in chalk the tenth of a candle would be equivalent to more than a full candle in a coal mine.

It is not so much the amount of light thrown on the surface that matters, but rather the amount reflected back, and that is why I hold that the cause of nystagmus is the absence of colour in coal, because, for that reason it does not reflect back the light. (It only reflect as much as it does on account of its crystalline structure. If it were not crystalline it would only reflect from 2 to 3 per cent. of light.)

The three things I want to see introduced into coal mines are: (1) colour, (2), more fresh air, and (3) a proper amount of light of

a suitable quality, for I quite agree that a fifth or a tenth of candle power is a ridiculously small amount of light to work with. If you are about to establish a standard of quantity, I wish you also to establish a standard of quality. My ideal is the carbon filament or the tallow candle—a proper amount of yellow, and not too much violet.

I wish here to acknowledge that I got the idea of the spot of light moving in a dark room from Dr. Edridge-Green, and the method of making an analysis of light from one of your secretaries, Mr. J. S. Dow.

c. Discussion

The Chairman: Mr. Elworthy has given us some very interesting aspects of the subject. And now it would be interesting, I think, to hear a physiologist, and therefore I will ask Dr. Haldane to speak. Dr. Haldane is well known for all his work in mines, and I am sure we shall be glad to hear what he has to say on this subject.

Professor J. S. Haldane, F.R.S., Oxford: I am afraid, Mr. Chairman, I have not much I can usefully say on this matter. I came here to learn. From one or two remarks Mr. Elworthy made, I take it he thinks the air in the mines has some influence in the causation of the defects we are here to discuss. I think, however, it is probable that it has nothing to do with the question of nystagmus. The air in mines is extraordinarily pure, as a whole; a miner works in an extremely good climate, as a general rule. If you analyse the air at the working-face in an ordinary well-ventilated mine—as nearly all big mines now are—you will find the air extremely pure. There is often, it is true, some fire-damp in the air, methane instead of nitrogen, but it seemed to be the same as ordinary air, in my experience, except that one's voice was altered a little. I was quite happy in it, and I kept animals in it for quite a long time. It is an indifferent gas, like nitrogen. I do not think we can blame the air in mines with regard to this condition, and I think it will be well not to complicate the problem by introducing it.

I came really in the hope of hearing something from the Chairman, and others too, perhaps, on the general nature of nystagmus. It interests me very much from the point of view of other forms of what one calls localized neurasthenia, such as we have seen so much in connection with the war. I have particularly had to do with what I may refer to as neurasthenia of the nerve centres which govern breathing, the respiratory centre. That is a very common condition, in which the breathing, instead of being of the ordinary deep and fairly slow type on taking exertion, becomes very rapid, shallow, and inefficient. There is a very well known group of symptoms which are associated with this form of neurasthenia of the respiratory centre. The same condition can be produced ex-

perimentally by simple fatigue, that is to say, by breathing against resistance, as one sometimes notes in some forms of mine rescue apparatus. The breathing is more rapid and more shallow, and you get a chronic condition, very much like that of neurasthenia as so often seen in civil life, as well as in soldiers during war time, sometimes as the result of over-strain, very often following gassing, and also seen in connection with some forms of infectious disease. The point is, that in these cases the respiratory centre is working too quickly; instead of the breathing being deep and slow and effective, it is rapid, shallow, and ineffective. You find the same sort of thing in connection with the nerve centres governing the rate of the pulse, and so on, a form of localized neurasthenia affecting those centres. There are very often other manifestations of the same sort. For instance, photophobia after gassing is very common, though there is no need to speak about that here. The Chairman, particularly, could say much more about that than I can. I am very much impressed with what are called the localized neurasthenias, and their relationship with some form of fatigue. There is fatigue of some kind connected with the miner trying to see in semi-darkness, and that, apparently, leads to this chronic nervous condition. I should like to see this produced in animals experimentally. I do not mean that anyone should deliberately make himself into a case of nystagmus, but that he might be able to produce it just for a time, as one can fatigue the respiratory centre, or even by fatiguing the heart, you can reproduce the condition, to some extent. I hope to hear something on this aspect of the physiology of the subject from the Chairman, and from any others here who have studied the subject.

The Chairman: It is a very wide and interesting subject, and we medical men must not monopolize the whole of the discussion. I will now ask Mr. Armitage, who is Chairman of an important colliery, to give us his opinion on the subject.

Mr. Armitage, M.P.: I am not able to speak on this subject in the same way as Dr. Haldane has, but I thought it might interest members to hear some details about what is going on in some of the big collieries in Yorkshire in connection with this subject.

You may remember that the Government offered a prize of £1,000 in 1911, which was given anonymously then, but, I think, it is now common knowledge that it was given by the late Sir Arthur Markham. It was for the best electric lamps, the specification for which was drawn up, from the colliery point of view, by Charles Rhodes, and from the electrical point of view, by Dr. Merz, and they were the people who decided to whom the prizes should be given. A very large number of lamps came in from all portions of the world, even from as far away as Japan, and the result was the C.E.A.G. lamp got £600, and a number of other designs received £50 apiece. We, therefore, placed orders for 10,000 C.E.A.G. lamps. We

have had those working since 1912, the year they were introduced. We are now beginning to get the facts and the knowledge which, I think, will be good enough, in a very short time, to warrant the Government taking a very much more active part in this work.

Some of you may like to know the results we were getting from these lamps. We noticed that there are three things happening about these lamps. First of all, since their use, there has been a reduction in the amount of nystagmus, and there is a reduction in the accidents. The lamp enables the men to get away from the pit bottom much sooner than they could with the old lamp: they can get their eyesight quicker. At Hickleton Main Colliery, one of the largest, they had, in 1912, 2,667 men employed, and there were 459 accidents, and 12 cases of nystagmus. That was the year before the C.E.A.G. lamps were introduced. In 1919, there were 2,058 men employed, and the number of accidents 256, while the cases of nystagmus numbered seven. I admit that the cases of nystagmus had varied considerably, because in 1918 there was no case of it at all. In another colliery, Broadsworth Main, one of the mines in the near neighbourhood, the number of men employed before the C.E.A.G. lamps was 2,464, the accidents were 439, and the cases of nystagmus 11. In 1919, 2,911 men employed, and 419 accidents, with five cases of nystagmus. In a neighbouring colliery, employing about the same number of men, but where they never used oil lamps—it was sunk about the same time that the C.E.A.G. lamps came in—they had about six cases of nystagmus a year.

Dr. F. Shufflebotham (Newcastle-under-Lyne): I have taken an interest in the subject of miners' nystagmus for many years, and it seems to me that it is only within the last year or so, or perhaps the last month or two, that there has been any active interest and real effort to come to grips with this disease, and try to check its incidence. And I think it is most hopeful when a society like the Illuminating Engineering Society joins with the Royal Society of Medicine in endeavouring to combat this disease. I feel that Dr. Llewellyn has under-estimated, and considerably under-estimated, the number of cases of miners' nystagmus which exist in this country. There is a great difference between the number of certified cases, and the actual number of these cases in existence. I am sure it is only through such agencies as these societies that we can really tackle the disease as a whole. I am confident that the Illuminating Engineering Society is anxious to do all it can to produce the best possible illumination of the mine, and medical men connected with the mining industry, and physiologists like Dr. Haldane, and others, are anxious to check the disease.

There is one other point I would refer to, and it is this: both Dr. Llewellyn and Mr. Elworthy have referred to it. It cannot be too clearly understood that miners' nystagmus is a general nervous

disease: that it is not simply a disease of the eye, and I only hope that this will be realized by every section of the medical profession and by hospital authorities too: because at the present time—I do not want to cast reflections on the specialists of this country—specialists have, to a large extent monopolized the treatment of these cases, and while those specialists have been in a position to deal with the eye symptoms, and the treatment of those, the general nerve symptoms, which are so distressing and cause so much incapacity for work, have been practically neglected. I only hope that in the future there will be some improvement in this direction also.

Mr. Fudge said: I am Secretary of a Government Committee, which has been at work for the best part of twelve months, and their chief object is to improve the miner's lamp. And I think I may say—though I am not in a position to give details—that we are getting on satisfactorily. I must confess, however, that when we came to tackle the question, we found there was no broad road along which an easy advance was possible. I see a number of lamp makers' representatives, and therefore I feel somewhat diffident about saying what I propose to say, namely, that they have served the colliers of this country very well. I have visited a number of the proprietors at their works, and they have taken a great interest in the subject. And they have done much research—not only technical research, but pure scientific research, too—to improve the safety lamp, and they have improved it. But there are very definite limits to it, taking the lamp as it is at present constructed. Taking the electric lamp first, there is a definite limit in regard to that. That limit is in the matter of its weight, because of including a secondary battery. The candle-power could be increased, and, I suppose, indefinitely increased, by adding to the weight of the lamp. But the lamp is now about as heavy as a miner's lamp can well be. The only way to increase the candle-power of the electric lamp, on the present lines of construction, is, first by increasing the efficiency of the battery. I think a good deal may be possible in that direction. Secondly, there might be improvement by eliminating a very large amount of the shadow cast by lamps now. I do not know what the total illuminating power of the bulbs of these electric lamps is, but much of it is cut off by the electric lamp bulb, and by the pillars and the top and bottom of the lamp. It seems to me much of that shadow can be obviated by care in the matter of design. Then there is the question of the efficiency of the bulbs, and an improved quality of glass used. Details of that kind are very important.

But what I want to emphasize is, taking the present principle of construction of the electric lamp, and the limiting factors with

regard to its use in the pit, there is no royal road by which we can increase the available light two, three, or four times. Until a genius comes along, the improvements must be in matters of detail.

Then I would like to say a word about the flame lamp. The possibilities of improvement on the present lines are limited in that too, I think. We have lamps now which will give anything up to $2\frac{1}{2}$ -candle power, but necessarily, I think, those lamps are more complicated in design than the old simple Mueseler, and more liable to go wrong, as well as, in certain circumstances, more liable to go out. There is also the rather serious defect of liability to over-heating. Again, the size of the lamp is limited, and with the more perfect combustion of the oil, which is contingent on a better light, the over-heating is a considerable difficulty to get over. Some of the experimental lamps we have now got in hand get so hot that, after they have been burning a short time, especially in sluggish air, they are too hot to be held. Of course, there may be possibilities in the direction of using acetylene for lamps; there is no safe acetylene lamp at present.

There is only one other point I would mention, and that is one on which Mr. Elworthy lays some stress, and Dr. Llewellyn also mentioned it. I refer to the question of the reflecting power of the surfaces surrounding the lamp when the lamp is in the pit. The black coal face absorbs anything up to about 90 per cent. of the light, a very large proportion. Speaking in the terms of a fairy-tale, if that coal face could be turned into white coal, I think the electric lamps we have at present got would be amply sufficient. The question is—and it is entirely one for the practical men of the pit—whether it is possible, as an experimental measure to start with, to carry further the whitewashing which, I think, is carried out now in a good number of pits, to whitewash the pit bottom, and, perhaps, along part of the road. I know the practical difficulties are very great, but so also would the results obtained be very great. The effective illumination in the pit would be greatly increased by even a limited amount of whitewashing, more than by doubling the power of the lamps. It is a matter for the practical men to consider, whether there is anything more they can do in that direction.

One more word. As the Committee, of which I am Secretary, evolves experimental types of lamps, they propose to apply to them—provided they are safe—the only proper test which can be applied, namely, the test in actual pits; and if there is a colliery agent or a colliery manager here who would care to co-operate with the committee in that work by giving a careful trial in their pit to an experimental lamp, I shall be glad to get into touch with him, and I have no doubt we can do some business.

Mr. Hailwood : In talking of the electric lamp and the benefit to be expected from it, it is singular that in one division of Yorkshire there are 69,341 electric miners' lamps, and they are apparently not giving such a good result as one would expect. Otherwise, I cannot understand how it is that the Manager 'of the Coal Owners' Mutual Indemnity Society, in giving evidence before the Compensation Committee in 1919, stated that the number of nystagmus cases had advanced from 30 in 1907 to 515 in 1918, and that at a period when there is such a large use of electric lamps. I should have thought the number of cases would have gone down. So it makes one wonder whether the electric lamp is the remedy.

'Another peculiar thing is, that in the country there were 156,521 electric lamps in use in December, 1918, and we have 90,200 of the combustion-tube type with a candle-power of 0.99. The collier uses his lamp roughly, and for that reason we cannot give the maximum efficiency. In the particular case we had a narrow slit, through which the flame passed, and subsequently we opened the slots because we could not get the proper attention to the lamp in the lamp-room, nor could we get the miner to realize his lamp was worthy of a few moments' attention. I think there should be a little education of the miner in these matters from his own Federation. As they are considered to be skilled men, one would suppose they would be educated up to the essentials of their own trade. Taking 156,000 electric lamps, giving apparently one candle-power and 90,000 combustion-tube lamps, it leaves 499,985 lamps of other kinds in the country. One would think the number of cases of nystagmus would go down if better illumination is the principal remedy. But it has gone up from 4,500 to 6,000 cases, and since the war the cases are jumping up in number in a peculiar manner. When I heard this paper was to be given, I wrote round to our customers. We have 192,000 lamps; one-third of the lamps belong to us. We got replies from 136 pits, which have in use partly combustion-tube lamps, partly oil. Forty-one pits report no cases of nystagmus, 26 pits reported a reduction of cases of nystagmus, while 46 pits reported increases. But what astonishes me is the great variation in the numbers of cases, even at pits not more than a mile or so from others. I have 2,835 lamps in one group, and 90 cases of nystagmus are reported there. In another pit, within three or four miles, there are 1,058 similar lamps, and they have two cases of nystagmus. Take another pit, five miles from there : 2,477 lamps, six cases of nystagmus. Another has 1,100 lamps and 26 cases of nystagmus. There are other parts of the country where large numbers of lamps are in use, and the cases of nystagmus number only one or two, and I speak of identical lamps. If defective illumination is the principal reason, I cannot understand why the figures of nystagmus do not run better together

—why there is not a steadier proportion. My opinion is that there must be something besides illumination having a bearing on this matter, though illumination may be an important factor. Men I have spoken to who work in hot dusty pits express the opinion that dust getting up their nose and irritating the canals of the nose, affect the eyes, and this may be an important factor. One notices how many people are wearing spectacles compared with former times. A manager who was at a local school said: "It is singular that in the school to-day the doctor comes and orders spectacles in a large number of instances; but as soon as a man goes to the pit, he discards his spectacles, and one would think that was a fitting line to enquire on." In some districts, where the pits are hot, and the men come from their work soaked in perspiration, they can be seen in the open air above wearing only a thin cotton vest or shirt, and they make no effort to protect themselves. I do not know whether it is from sheer bravado. If nystagmus is, as the doctors say it is, a nervous disease, surely there should be some protection from extremes of temperature.

Mr. J. George: I represent a lamp firm, and I have listened very attentively to the medical side of the question. I also speak as a practical miner, as one who has been brought up, from boyhood, in the pits, and has risen to the post of colliery manager. In the beginning of the world the cry was for light, and we are still crying for it. We have various grades of light now; we have the electric lamp, but I make bold to say we have never moved an inch from the fundamental principles given us by Sir Humphry Davy. One interesting point raised was, that the electric safety lamp hurts the men's eyes. That is so. But let us look at the further side of the case. Dr. Lister Llewellyn talks about men not seeing the sun. I often went down the pit at 6 in the morning and did not come up again until 6 at night. I worked in an open lamp pit at that time, and when I came out my eyes were sore if the sun shone in my eyes. What hurt the eyes was not the sun, but the long confinement in the pit. If men suffer from the electric safety lamp it is not due to the lamp, but to the men's eyes having previously suffered from an indifferent light. I listened with rapt attention to the last speaker, and I could give you instances from a town in Lanarkshire. There are two pits, (a) in an open lamp district, and (b), in a safety lamp district. If you look at the faces of the men working in pit (a), those working with the open light and compare them with the faces of the men in the safety lamp pit, you will see that the faces of the men in the safety lamp pit have the eyes drawn, and those are the men who have not been reported as having nystagmus, but they are in the early stages of it. I have to wear glasses now because of having suffered from nystagmus. In Scotland we call it the "clanny blink."

I would like to call attention to the extra combustion which is going on all over the pit which uses oil lamps, as compared with that when electric lamps are used. Take a colliery using, say, a thousand lamps, and think what that extra combustion means in using up all that oxygen in the burning, meaning, of course, a double supply of carbon dioxide in the pit. Miners with nystagmus must take much of the blame themselves. Men are afraid to touch the lamp in case it goes out, and they try to see to work when there is practically no light.

I was very pleased to hear Mr. Armitage say what he did. Where electric lamps have been installed I am sure, from my experience and from what my friends have told me, that accidents have been considerably reduced. And electric lamps do not cost more than others, the cost is about the same. The miners themselves prefer the better light of the electric lamp. In one district in Scotland the miners can have the best oil lamp to go down with for nothing, but they prefer to pay 9d. per week and have the electric lamp. That will show you what an advantage it is.

Mr. D. Leighton Davies (Cardiff): Speakers have emphasized the point that nystagmus is part of a general nervous disease, but it is difficult to understand how a deficient light can affect the general nervous system, cause the tremors, the restricted visual fields, and so on. I feel that there must be some other cause producing what we speak of as miners' nystagmus, of which the eye symptoms are a small, but a very important part. I think it is possible that the disease is a poisoning, due to emanations of gases from the surface of the coal, it may be in the form of hydro-carbon, or it may be some other factor which has not yet been discovered. Or it may even be micro-organisms. What are the proofs, or the evidence, on which I say this?

First of all, the mines which are least gassy, those in which a naked light can be used, are those in which nystagmus is rare. And I think this is due to a diminished amount of gaseous exhalations from the working face. Those men who are working at the face of the coal, where, at any rate, ventilation is less perfect than elsewhere, are much more frequently attacked with nystagmus than are others who are working in better ventilated areas, such as hauliers. It has been shown, by many observers, that nystagmus is more prevalent in some places, and at some seasons, than others. May not this be due to a difference in the transfusion of noxious materials? Nystagmus is rare in those who have worked only a short time underground. But when it does occur in those cases, the nervous symptoms are very prominent, as if they were very vulnerable to the conditions obtaining in the pit. It is a case of chronic poisoning, with the occasional incidence of a more acute type.

A very interesting point concerns the visual fields. Mr. B.

Cridland has pointed out that many of the cases showed a concentric contraction, and that the fields for blue and red are more contracted, in proportion, than the white. For a long time past I have carried on investigations into the visual fields in cases of chronic poisoning caused by the presence of pus, such as in cases of bone abscess, and I have been struck by the fact that in such cases of chronic auto-intoxication there was a marked concentric contraction of the visual fields, and the field for colour was more contracted than that for white. So that the field in miners' nystagmus is the same as that attending poisoning due to other conditions. If the theory is true that nystagmus is a neurosis produced by chronic poisoning, how are we to explain the number of cases of nystagmus diminishing in the better-lighted mines? I think this can be explained in the following way:

The movements of the eyes cause less inconvenience to the miner suffering from nystagmus under moderately good light than when the intensity of the light is diminished, or than when it is particularly brilliant. But, although these symptoms are less troublesome, the nystagmus has not disappeared. And this may also occur in the better-lighted mines. But the man still has nystagmus. This possibly may be explained by the fact that when he is not in the presence of good daylight, he has to focus with the peri-macular region, and so nervous disease comes in and upsets the balance, and so the nystagmus becomes more marked. Therefore when the miner who has nystagmus is supplied with a better light, he will be able to carry on his work, in spite of his nystagmus, because I think it has yet to be proved that improved light diminishes nystagmus. All it does, I think, is to allow more men to go on with their work. A large number of men are continuing work now in spite of their nystagmus.

Mr. Harrison Butler (Coventry): It is unreasonable to expect the introduction of better lighting to produce an immediate reduction in the number of cases of nystagmus. Miners' nystagmus is a disease which may take ten to twenty-five years to develop, and if we are going to improve the lighting of our mines, it will be, perhaps, ten years before the nystagmus curve shows a marked fall. Mines are, I believe, full of men with eyes in the pre-nystagmus stage, and to them, the introduction of a bright light will increase their nystagmoid indications at first. Because one of the early symptoms of the condition we are discussing is photophobia; a man who has been working with an illumination of, perhaps, one-tenth of a candle-power, will at once have to give up work if faced with a brilliant light, and this will make the improved lighting appear not to have any effect.

Dr. Shufflebotham has just said it is only this year that the question of miners' nystagmus has received full recognition. But

I would point out that as early as 1912, I introduced a discussion at the Oxford Ophthalmological Congress on the subject, and very many of us have drawn attention to the fact that the eye symptoms are only a part of the disease; it is a general nervous disease. And—I think owing largely to that discussion—the Government scheduled eye twitching as a disease, one which could be registered, and in respect of which the men could claim compensation as for nystagmus.

Dr. Harford (London): I have taken an interest in this disease because, during the war, I had medical charge of a Division in which were a large number of men from the mines of Yorkshire, Cumberland, and Durham. And I have published, in the *British Medical Journal*, a strong corroboration of the facts which Dr. Llewellyn has brought out this evening. I emphasized the opinion that it has been a misfortune that this disease has not been sufficiently dealt with by the neurologist, apart from the ophthalmologist. And, on looking at the text-books on medicine, it is remarkable to find such an important disease as this hardly mentioned in some of them. I have received from Dr. Christie Reid, of Nottingham, a letter in which he says he was much struck, when in the mining district of North-Eastern France, with the complete ignorance of the disease, though, from conversation with the miners, he ascertained that their methods of getting the coal were much the same as ours. He wrote, on his return, to the Manager of the Briey mines, and he replied that many were familiar with the disease, but since the introduction of electric hand lamps the disease has been eliminated, and is now practically unknown. And he says, "Why can't our colliery authorities do likewise?" He speaks of his attempts to get electric lamps introduced into the Notts. and Derby coalfields, but the only result has been to secure that a few individuals with severe nystagmus shall have electric lamps. That is tinkering with the matter.

I have not had the advantage of dealing with this subject on the spot, but I have carefully studied the literature of it, and I have no doubt the condition is due to faulty illumination chiefly. Still, as one speaker said, there are numerous subsidiary causes, especially the fact of accidents occurring to the head, quite apart from the defective eyesight; also the other conditions which lead to impaired health.

The most important case I had to deal with was a man who apparently had got into the Army in the ordinary course, having passed the tests. When he came to me, however, he was a hopeless invalid. The sight of this wreck of humanity in the hospital convinced me of the great importance of the disease, and impressed me with the fact that every one of us who takes the least interest in it ought to use every possible influence to get the matter

dealt with. And it has been clearly demonstrated that illumination which is sufficient is the great point. As to why we should sometimes get results which are apparently contradictory, I would point out to those who are not medical men that the diagnosis of different diseases is not an easy matter, and that difficulty is present in this case. There are, I think, many people who are suffering from the disease in a variety of forms, but whose case is never diagnosed. We know of more cases than previously because there is now greater interest aroused in the subject, and, as more are acquainted with the facts, cases are more generally recognized than formerly. And, as has been said, statistics may not at once show the benefit of the reform. I think there should be such attention devoted to this matter that it should be considered as much a reproach to have a case of miners' nystagmus as it is for a match maker to have a case of "phossy jaw." When the submarines were making havoc no one said, or was allowed to say, "We cannot deal with these submarines." The Navy expert said, "You must deal with them." And now that we have this disease (miners' nystagmus) having such a tremendous effect on the men, it ought to be imperative for reform to be taken up; and I hope a result of this meeting will be that very strong action will be taken to deal with it.

Mr. V. V. Pass: In reference to Dr. Llewellyn's remarks concerning the need for lamps of 4-candle power, I think Mr. Fudge pointed out the chief difficulties which stand in the way of that. From some sources we have the statement that the present lamp is safe, from other sources it is said it is not. In regard to a 4-candle power lamp, the weight is the main difficulty, but if a satisfactory electric bulb could be got, such an electric lamp would very much improve matters. We have got over 67,000 lamps in the South Wales district, and the greatest punishment you can inflict on a miner who has once used an electric lamp is to make him use an oil lamp, even if it is only for a day.

Mr. G. H. Pooley, (Sheffield): One point to remember is, that the miner usually goes on working until the last moment that he is capable of doing so, because he likes comfort, and does not want to have to be content with a sum which is about half his regular wage. Hence many miners continue working although they know they have nystagmus: they work until they virtually drop at the coal-face.

In my opinion, miners' nystagmus must be due to some instability of the cerebral centres, caused by the defective illumination under which the miner has to work, and, though to an unknown extent, by impurities in the atmosphere in which the men work. For it is when working in the outlet air, in which the lamp gives a poor light, that the cases of nystagmus most frequently occur. And this impure air is breathed by the man. Our information is not yet full enough

to allow us to estimate the effect of prolonged inhalation of small proportions of coal gas.

Dr. Llewellyn has carefully estimated the amount of illumination, and I agree with his findings. All that he has published in his book in 1912 has been found since to be correct. The instability I spoke of I believe to be due to the prolonged exposure of the miner to these conditions, but the symptoms remain in abeyance for a long time, and they are exacerbated when activated by a shock or by bad health. This may happen even when the collier has been away from the unfavourable conditions for some time. For instance, men who enlisted and went off voluntarily into active service, and had been previously working regularly five days a week at the coal face, when they went back to this work after coming back from the war, broke down with active miners' nystagmus, and in a bad form. The collier works in such feeble illumination as to require the special adaptation of his eyes to it, and in these circumstances the macula becomes a "blind spot."

I think the question before you is, can the illumination at the coal face be increased, not simply by improving the lamps at present in use, but by introducing something 60 times as great? At the present time they are employing electrically-worked coal-cutters at the coal face, and I have been wondering whether it would be possible to light up the coal face with the electricity which runs that machine. I am not an electrical engineer, but possibly something along those lines could be worked out.

Dr. Ettie Sayer (London) advocated experiments with yellow light. She fully agreed with the speaker who talked about poisoning in the mines. Writer's cramp is due mainly, of course, to the writing, but if the patient has septic teeth it comes on quicker. Similarly, if the miner has a toxic condition due to his work, he is more liable to develop miners' nystagmus.

Mr. Bernard Cridland (Wolverhampton): I think when we speak of miners' nystagmus as a disease of the nervous system we ought to go further, and be more scientific: we ought to speak of it as a disease of the ocular part of the central nervous system, for I feel sure every sign and manifestation of the disease can be referred to the ocular centres—I mean the whole ophthalmic apparatus. It may be toxæmia, it may be fatigue, or what not. Every symptom, however apparently unconnected, can be traced to action on the higher ocular centres with the other centres of the brain.

I am interested in what has been said about acetylene lights, and I had intended asking whether it would be possible to use them.

And I would particularly like to ask whether this discussion is going to be allowed to end here, namely, by being simply recorded in the journals of the societies concerned. Has not the time arrived when we ought to have some sort of joint committee,

consisting of representatives of the Illuminating Engineering Society and the medical profession, and ask that committee to draw up some sort of report, and thus get an idea of the lines along which research can most profitably be undertaken? From the ophthalmic side, we have already got the needed machinery ready. With great respect to the Ophthalmic Section of the Royal Society of Medicine, I suggest that the Council of British Ophthalmologists, as representative of British Ophthalmology in general, is the body to be approached with a view to their appointing representatives on such a committee. And I suggest that they would not appoint only ophthalmic surgeons, but any who are interested in the disease and have a knowledge of it. If success is achieved, it will be a great national investment. Such a report, when drawn up, should be sent to the Home Office and other Government departments. Perhaps that would be one more stimulus to the taking of further action in so important a matter.

Mr. A. L. Whitehead (Leeds): I am very deeply interested in this question, working, as I do, in the district from which Mr. Armitage comes.

We all realize that this is a very complex problem; it is not just one single factor which is at work. I think Dr. Haldane hit off the trouble when he said it was due to the miner trying to see his work under disadvantageous conditions. This difficulty in seeing may be due to any of a number of causes; to some error of refraction, to some dust in the mine, to inhalation of coal gas. But the most important thing is, that he must have light to see with, and obviously, our first duty is to increase, in every possible way, the illumination at his work. Although Dr. Llewellyn's figures seem to show that if you increase the light by half a candle power you can cure the nystagmus, I do not think I can follow him as far as that. Still we must increase the illumination.

The practical point seems to me to be, as Dr. Llewellyn said, the portable light, a head light preferably, which the man can direct on to his work, and increase the power of that light by the provision of adequate reflectors. We increase the light-power of our motor lamps by reflectors, and to an extraordinary degree, and, instead of having lamps which distribute their illumination in all directions, we ought to concentrate it. I think that must be the key-note in the mining of the future.

Mr. N. Bishop Harman (London): Dr. Llewellyn showed an excellent head-lamp arrangement, but I would like to ask how far is it safe? He knows the rough usage these lamps are submitted to in the miner's hands. Lamps should be severely tested in the testing department before being used in a highly dangerous mine.

With regard to the weight, everyone has talked about the development of the electric light on the lines of the filament.

When I was at the Cavendish Laboratory, Cambridge, we were shown a vapour lamp which gave a lovely light; it could be looked at as long as one liked without injury. And we have seen the other extreme, the mercury-vapour lamp. Why cannot the engineer get us a lamp of that sort? Nothing will convince me that the mercury-vapour lamp can be looked at comfortably. Surely there is an electrical genius who is able to do something in this way for the miners? I confess I have been quite disappointed at the tone of this discussion. I had expected to see this evening demonstrations of improvements which I had hoped might by this time have been achieved. We have now learned the reasons why there are not such: there is still debate as to the cause of the condition. But surely, since Sir Josiah Court wrote, there cannot be any doubt; his papers on the subject are most convincing. And it has not been disputed that in mines where the safety lamp is used, nystagmus is most prevalent, and where it occurred in the others, the victims were those who had previously been working in dangerous mines. On the continent this fact was recognized, and it was attempted to give the credit to one of their own countrymen. You have heard what Dr. Harford said, and that is no doubt confirmed by what occurs in other countries too. Cannot somebody start a research with the object of producing a golden-vapour lamp which can be produced by a small battery, one which, though of small weight, shall yet have sufficient illuminating power? If you can do that, it seems to me that the problem is solved.

Mr. Leon Gaster, Secretary of the Illuminating Engineering Society: We have a series of other interesting contributions, which will appear in the *Illuminating Engineer*.

I wish to thank the exhibitors for their kindness in showing us their further developments. The effect of Mr. Fudge's remarks is to increase the encouragement the Society feels in seeking further co-operation on all points connected with light. The Home Office has shown a keen spirit of co-operation. If we can show that it will be useful, the Mining Department of the Home Office will take advantage of any assistance offered. The idea of forming a Joint Committee has already been mooted, and I hope to convene such a Committee.

Dr. Lister Llewellyn (in reply): I want to call the meeting's attention to the fact that when the meeting started two oil lamps were lit. They are now both out, yet they have not been touched.

I would insist that the standard to aim at is to get a light in a safety lamp up to the standard of that in the naked light pit, and to do that, you must have either a 3- or 4-candle power lamp, or bring the light nearer to the coal face which the man is working on. If you do the latter, on account of the great law of inverse squares, you increase the light used in a manifold degree. I think the

solution of the problem lies in the universal introduction of the cap-lamp: which weighs $2\frac{3}{4}$ lbs. and gives a large area of illumination. I do not think there is any danger of burning. Both battery and cap are locked. It would give a light five times as much as at present. In the coal mine you must either increase the power of the electric lamp, or you must bring the light nearer. This lamp gives a broad illumination, there are no shadows, and as the light does not fall on the eyes, the worker feels no glare. (Two speakers here expressed an opinion that the lamp was not safe.) I do not think there is danger. These are used in America largely. There is no greater danger with this than if the miner falls on one of the other lamps. (I have exploded gas with them.) More explosions have been caused by oil "safety" lamps than by anything else.

The Chairman: I feel constrained to say that the great difficulty is connected with the lamp, and I came here in the hope that that had been overcome. I have no doubt whatever that the difficulty in regard to the incidence of miners' nystagmus is the small illumination, and I think Dr. Llewellyn has proved that conclusively: that the remedy consists in getting a safe increase in illumination, in some way, either by direct, or by reflected illumination. I do not know anything about the practical details, or how far it is feasible. From the scientific point of view, it is a very difficult matter to devise an electric lamp which shall be absolutely safe in fire-damp. Dr. Llewellyn gave me the impression that that had been safely accomplished, but I am not convinced yet.

Many of the speakers this evening must have curtailed their remarks, owing to the feeling that they were standing in the way of others, and I want to say I hope they will expand them for publication, as this is a very important discussion. And if there are any here with views and they have not spoken, I hope they will send their remarks to the *Illuminating Engineer* for inclusion. I think this discussion may be of some considerable practical importance in supporting any action which may be taken by the Home Office, or in promoting such action as may be considered desirable.

ANNOTATIONS

The Teaching of Ophthalmology

The vexed question of the teaching of ophthalmology is discussed in three papers read before the October meeting of the Section on Ophthalmology of the New York Academy of Medicine, by Dr. F. H. Verhoeff, of Boston, Dr. M. Wiener, of St. Louis, and Dr. A. Duane, of New York, respectively. They are published in the January number of the *Archives of Ophthalmology*. Verhoeff deals