(5) whether the mining industry of this country under existing conditions is maintaining its competitive power with the coalfields of other countries.

The chairman of the Commission is the Right Hon. W. L. Jackson, M.P., chairman of the Great Northern Railway Company, and he has fifteen colleagues. Coal-mining interests are represented by Sir W. T. Lewis, the eminent South Wales colliery owner, Sir Lindsay Wood, chairman of the Durham Coal Trade Association, Mr. A. C. Briggs, of Normanton, Yorkshire, Mr. J. S. Dixon, the Scotch coal-master, president of the Institution of Mining Engineers, Mr. A. Sopwith, of Cannock Chase Colliery Company, and Dr. C. Le Neve Foster, F.R.S., professor of mining at the Royal College of Science and Royal School of Mines. The working men's interests are entrusted to Mr. W. Brace, of the South Wales Miners' Federation, and Mr. R. Young, of the Northumberland Miners' Association. Transport interests are in the hands of Sir G. J. Armytage, chairman of the Lancashire and Yorkshire Railway Company, of Mr. Thomas Bell, coal exporter of Newcastle-on-Tyne, and of Mr. J. P. Maclay, shipbroker, of Glasgow. Geology is represented by Mr. J. J. Harris Teall, F.R.S., Director-General of the Geological Survey, by Prof. C. Lapworth, F.R.S., of Birmingham University, and by Dr. E. Hull, F.R.S., formerly Director of the Geological Survey of Ireland, whilst chemistry is represented by Prof. H. B. Dixon. F.R.S., of Owens College, Manchester.

The main interests involved are thus represented with the exception of the consumers. The metallurgical industries, which consume such vast quantities of British coal, do not find their spokesmen on the Commission. This is a matter of regret, inasmuch as metallurgy was so largely represented on the previous Commission; and the investigations of Sir Hussey Vivian, Dr. Percy, Mr. Hartley of Wolverhampton, and Mr. G. T. Clark of Dowlais, on waste in combustion were amongst the most valuable of the results of the Commission.

The task of the Royal Commission to estimate the available resources of the British coalfields is one of great difficulty, and it is to be feared that any estimate must be of slight value, owing to the impossibility of prophesying with accuracy either the rate of increase in production and consumption, or the limits at which mining may be carried on with profit. Prof. Hull, one of the Commissioners, has already published a reassuring estimate, although it is not in accord with the less optimistic and divergent views expressed by Prof. Stanley Jevons, by Mr. Leonard H. Courtney, by Mr. R. Price-Williams and by Mr. T. Forster Brown. The questions of the possible economies in the use of coal and of the adoption of better methods of working should prove the most fruitful field for the Commission's labours. Great Britain now produces one-third of the world's supply of coal; and more and more attention is being devoted to improvements in mining details. Although the use of mechanical coal cutters has by no means become as general as it has in the United States, where 25 per cent. of the output is thus obtained, there has recently been a distinct increase in the use of these labour-saving appliances. Moreover, endeavours are being made to economise in the consumption of coal, notably in the South Staffordshire coalfield, where the producer-gas invented by Dr. Ludwig Mond has recently been introduced as a cheap source of heat and power. That great economies in the home consumption of coal have been effected since 1871 is unquestionable. Indeed, Mr. Price-Williams has shown that, whereas in 1871 the iron and steel trade required 30 per cent. of the coal consumed in the United Kingdom, its requirements had been reduced to 16 per cent. at the time he read his paper before the Statistical Society in 1889. To further coal economies effected in the manufacture of iron and steel Mr. Bennett Brough has drawn attention in an article on the scarcity of coal in the *Nineteenth Century* (April, 1900). There is, however, still room for large economies in coal in the manufacturing industries; and the results of a searching inquiry into the subject cannot fail to be of permanent value and interest.

ON PAPER AND PEROXIDE OF HYDROGEN.

I DESIRE to show by means of the following photographs some special points of interest which occur when certain papers are allowed to produce pictures on a photographic plate in the dark. Some papers are themselves active, that is, if they be simply placed on or near to a photographic plate in the dark they act upon it so that after ordinary development a picture is produced. Other papers which are without this power can be examined by placing them on a photographic plate and putting behind them a plate which is giving off hydrogen peroxide, such as one of plaster of Paris or a pad of blotting-paper which have been soaked in an aqueous solution of this body, or a plate of polished zinc, or a piece of cardboard or glass which has been painted over with copal varnish or other body of that kind. There is also with regard to paper the action of writing and printing ink upon it.

The fibres which are used in paper making are[1] cotton, flax, hemp, wood celluloses, esparto, straw celluloses,

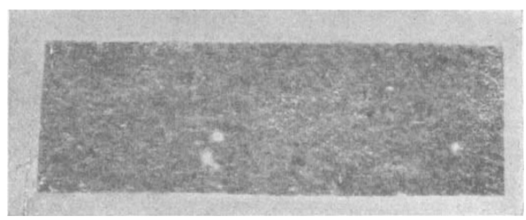

FIG. 1.

mechanical wood pulp. Of these bodies cotton and hemp are entirely without action on a photographic plate; all the other materials are more or less active, especially so is mechanical wood pulp and flax. If, however, any of these bodies, even the most active, be bleached, they lose this activity; the bleaching must, however, be very complete to destroy altogether their activity, and many papers although bleached are still active. On the other hand, the activity of a paper may arise, not from the paper itself, but from the size which has been added; this occurs when rosin is used.

The ordinary first-class papers are entirely without action on a photographic plate, but the common kinds are generally active. For instance, we may take some of the daily newspapers as illustrating this. The following results apply to copies issued on November 25, 1901: the *Standard*, *Daily Express* and *Daily Mail* all gave a dark picture, the *Pall Mall* a good, but not so dark a picture as the former papers; the *Westminster* and the *Sportsman* gave a faint picture, and the *Times*, *Globe* and NATURE only very faint pictures, and, lastly, the *Daily Telegraph*, *Daily News*, *Daily Graphic* and *Morning Leader* gave no picture at all. *Punch* paper is also not active.

With books and periodicals the least expensive are usually the most active; as far as I am aware the paper of high-class books is without action on a photographic plate. Fig. 1 is a picture produced by an active paper.

[1] Report on the Deterioration of Paper, Society of Arts.

This and all the following pictures, when no statement to the contrary is made, have been obtained by an action of the paper on the photographic plate for eighteen hours at a temperature of 55° C. Fig. 2 shows that absolute contact between the active paper and the photographic plate is not necessary, for in this case a thick copper

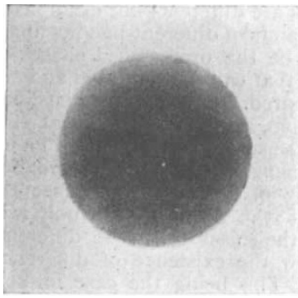

FIG. 2.

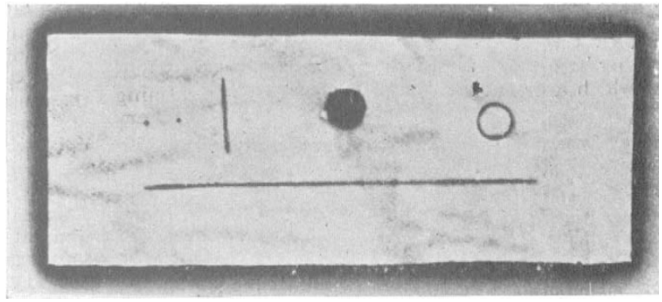

FIG. 3.

screen with a hole in the centre was interposed between the paper and the plate. This action of certain papers is shown in an interesting way with many cardboards. The following experiment, Fig. 3, was made with a photographic mount. A small piece was cut off and on it a long cut was made with a sharp knife passing through the external paper and into the substance of the cardboard. The dark circular patch was where a cork borer had been pressed about half way through the cardboard and the upper part removed. The black ring is a cut made by the same cork borer, but nothing removed. The two dots are two pin holes. Thus it seems as if an active vapour arising from the interior of the cardboard collected in these cavities and acted on the plate. A piece of cork acts in the same way; all the holes give

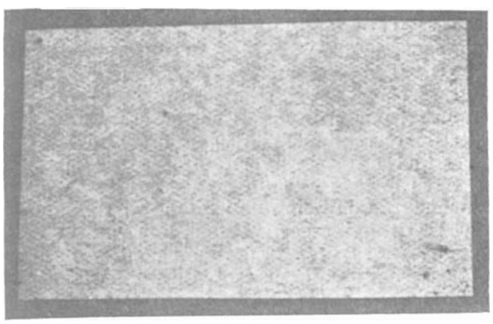

FIG. 4.

black pictures. In this figure the strong action of the recently cut edge is very striking.

Turning now to the case in which the action does not arise from the paper itself, but from hydrogen peroxide purposely placed behind the paper, we can obtain, again, some interesting results. The best way of applying the hydrogen peroxide is by means of a slab of plaster of Paris. This should be cast on a plate of glass and be about a quarter of an inch or slightly more in thickness. After it has been allowed to dry it may be painted over or dipped into a strong or weak solution of the peroxide of hydrogen. The slab is again allowed to dry. It will increase in activity for the first two days and after then gradually decrease, and if a 15 per cent. solution has been used it will be about ten days before it has lost its power of acting on a photographic plate. Other sources of hydrogen peroxide that are convenient to use are a bright zinc plate, or a piece of Bristol board, or a glass plate, that have been painted over with picture copal. Fig. 4 is a picture of the paper of the *Times* produced by placing it on a photographic plate and a charged slab behind it for four minutes. Fig. 5 is the picture of a writing paper 150 years old. The exposure to the hydrogen peroxide in this case was eight minutes, as the paper was thicker and less easily permeated by the peroxide. In the same way it is easy to obtain a good picture of the water-mark on a paper.

This application of the hydrogen peroxide to the back

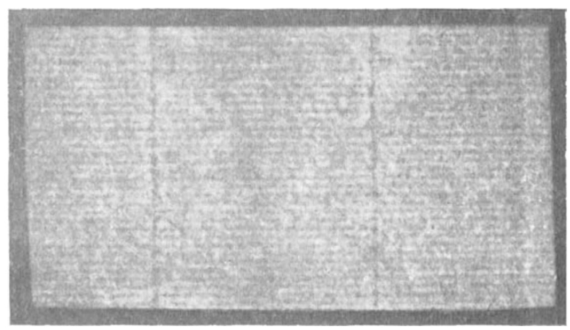

FIG. 5.

of a paper shows an interesting change which paper undergoes on being wetted. Take a paper which is easily permeated by hydrogen peroxide, wet it thoroughly in water, then hang it up at the ordinary temperature until

FIG. 6.

perfectly dry, and it will be found to be quite opaque to the hydrogen peroxide given off from a zinc plate or from copal or turpentine. This opacity of the paper, however, gradually passes off, and after two to three days at an ordinary temperature, or six hours at 100°, it has returned to its transparent state. With Ford blotting-paper the time of recovery is longer. On the other hand, if a paper be made only slightly moist, this facilitates the passage of the peroxide through it. If different substances be dissolved in the water used for wetting the paper it modifies the result obtained. With some substances the paper is not permanently affected, but with others—such, for instance, as alum—the paper remains opaque.

If paper be either written or printed on, the different effects which are produced have been already described.

FIG. 7.

The ordinary writing ink, allowed to dry on paper, renders it perfectly opaque to the action of the peroxide and retains this power for a very long time. The direction of a letter written in 1801 shows the writing with remarkable sharpness. The picture was produced by placing a zinc plate behind the letter. Then with regard to printing ink, it is a body which in itself is active, so that it has only to be brought in contact or in proximity to a photographic plate to give a picture. Naturally the activity of the ink varies much in different cases, and is in most cases capable of giving, not only a picture where the ink is facing the plate, but the printing

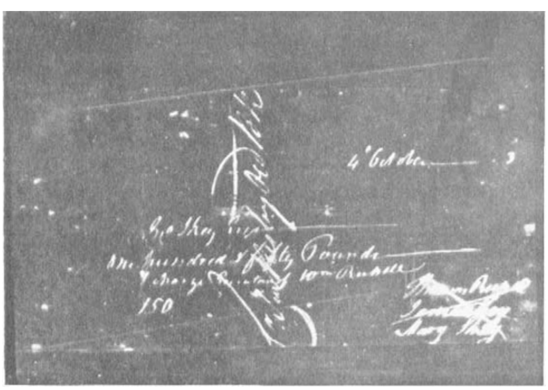

FIG. 8.

on the other side of the paper will also be depicted on the photographic plate. Fig. 6 shows this very well, the printing on both sides of the paper being very evident.

This difference of the action of writing and printing ink is well shown in the two pictures of an old cheque, Figs. 7 and 8. No. 7 is simply an ordinary photograph of the cheque, but No. 8 is a picture of the same cheque produced by placing it on a photographic plate with a zinc plate behind it; the printing-ink has become inactive, but the writing ink is still able to prevent the hydrogen peroxide from passing through.

W. J. RUSSELL.

WHAT ARE SEISMOMETERS INDICATING?

ONE thing which a modern seismometer does, and does in a satisfactory manner, is to indicate the time of arrival of the various phases of motion which constitute an earthquake. With two similar instruments at the same station, the time of commencement of a given earthquake is practically identical; but if the installations of the instruments are different—for example, if the instruments rest upon piers of different heights and construction—it will only be the pronounced phases of the subsequent movements that can be identified and which, therefore, can be compared. If our instruments, instead of being in the same room, are 100 to 800 feet apart, the only points in the two seismograms which can be identified will be the commencements and the pronounced shocks, which latter are of rare occurrence (see British Association Reports, 1885). As a rule not only will the general appearance of the seismograms be different, but measurements will show the existence of differences in period and amplitude. This being the case for seismograms obtained at stations near to each other, what coincidences can we possibly hope for in seismograms obtained at stations located at a few, several hundreds or several thousands of miles from each other?

Next, if we turn to a consideration of the character of the earth movements which produce seismograms relating to earthquakes the origins of which are at a great distance, we meet with observations the explanation of which is not simple. The first rapidly recurring tremors that a seismograph records are regarded as elastic waves of compression and rarefaction. One reason for this belief is that the observed velocities with which these precursors traverse either the surface materials or the body of the earth are such as would be expected for this particular form of wave in the media considered.

Following these forerunners by an interval of time which increases with the distance of the observing station from the earthquake origin are a series of more pronounced movements, usually referred to as shocks or large waves, about the character of which there have been differences of opinion. For earthquakes originating within a few hundred miles of an observing station we find that the records of such waves obtained from bracket seismographs are described as horizontal movements, whilst those from spring-lever seismographs are referred to as vertical components of motion. So long as the latter records are not shown upon a seismogram the former have always been regarded as described, their apparent magnitude being dependent on the multiplication of the writing indices. When, however, in a register we see entries for "vertical motion," neither the measurements for this nor for the corresponding entry for horizontal displacement can be relied upon. The reason for this statement, first made more than ten years ago, is that with severe earthquakes for 100 or more miles round the epicentre we have a vast amount of evidence showing that the ground is thrown into a series of surface-waves. These angular displacements cause horizontal pendulums to swing from side to side, whilst the levers of lever seismographs move up and down, the result being that both types of instruments, instead of measuring components of motion relatively to steady points, act as indifferent clinographs. In consequence of these considerations, at the end of 1891 I designed a clinometer for earthquakes. Briefly, this consisted of a balance-beam loaded at its two extremities, which when its frame was tilted in a direction at right angles to its length was assumed to retain its horizontality. A pointer like that of an ordinary balance attached to this beam acted as a steady fulcrum for the short arm of a light lever, the outer end of which rested on a smoked glass surface. An example of the seismograms giving the period and slope of earthquake-waves obtained by this apparatus will be found in the British Association Reports, 1893.