DISCUSSION.

Mr. R. Ferrier said that coal mining by machinery is strongly exercising the minds of colliery proprietors and managers in New South Wales, and the interesting paper submitted by the Author, at our last meeting, treated upon the construction and working of the Jeffrey make of coal-cutting machines, one of the several makes of machines which are now at work, and about to be put to work in our collieries. Each type had its advocates, and in many cases its particular application, and it therefore behoved the colliery officials to be very careful in the selection of the machine likely to best suit the circumstances obtaining at their collieries.

It might be interesting to know that in 1899 the United States passed Great Britain, and stood at the head of the coal producing countries, the outputs being 230,000,000, and 223,000,000 tons respectively. In the United States some 54,000,000 tons, or 25 per cent., was holed by machine; in Great Britain 4,000,000, or 1½ per cent. only was so holed. The output per man was greater in the States, due, no doubt, in a measure to machine mining. The total output of the collieries of New South Wales is only about 3 per cent. that of Great Britain or the States.

There are two systems of mining, namely, the pillar and stall, and the longwall. When working the former, long pillars were left in the workings to sustain the roof, whilst in the latter the whole of the coal was taken away. The former system was generally adopted in America, and the latter in Great Britain. It was generally conceded that the longwall system was the ideal one for machine mining; but it was difficult to adopt in many cases, especially if the seams were thick ones and clean, no pack dirt being available to sustain the roof as the workings advanced. In New South Wales most of the mines

were worked on the pillar and stall system, but there was a tendency to longwall work where circumstances would permit of its adoption.

The author in his paper instanced defects in revolving bar machines, and it might be interesting to give a description of a revolving bar machine named the "Pickquick," manufactured by Messrs. Mavor & Coulson, Ltd., of Glasgow, which had been successfully installed in nearly one hundred collieries of Great Britain. The machines were for longwall work, and arranged for electrical driving by either alternating or direct current motors, also for compressed air driving.

Plate V., Fig. 1, showed a "Pickquick" machine driven by a direct current motor. It is made in three sizes, to hole 3ft. 6in., 4ft. 6in., and 6ft. respectively. It consists mainly of five parts, namely: First, the cutter bar; second, the gear head; third, the motor; fourth, the switch box; and fifth, the hauling gear.

The cutter bar is of the best quality mild steel, and is machined out of the solid. The spiral thread formed on the bar acts as a worm conveyor, bringing the cuttings out from the holing, giving freedom to the cutter picks, and leaving space for the coal to drop. Taper holes with feather ways for the cutter shanks are drilled between and on the threads. The Gear Head completely encloses the main gearing. A bevel pinion on the motor shaft drives the double bevel wheel, which in turn drives the cutter bar pinion. This pinion is not keyed rigidly to the shaft, but is fitted with a feather projecting into its bore. This is for the purpose of allowing the bar to have a reciprocating movement through it. The mitre wheels are machined out of forged steel blanks, and after being turned and cut they are case hardened and ground true. There is a rack in the lower part of the gear case actuated by a pinion, which pro-

vides for turning the lower part of the gear head, together with the cutter bar, in a horizontal plane for cutting in, the horizontal movement being over 180 degrees. A worm fixed on the socket of the motor shell, gearing with a worm wheel upon the spigot of the gear head, provides for tilting the bar in a vertical plane, the vertical movement being also over 180 degrees. These two gears practically give the bar a universal movement, and this supplemented by the adjustment in respect of height provided for in the wheel brackets, about 5½in., enables a cutter bar to be readily brought into position for holding in any part of the strata, and at any inclination. The reciprocating motion given to the bar is obtained from a worm upon the boss of the bar driving pinion, gearing with two small wheels, each of which drives a toggle by means of an eccentric pin. The toggles impart a to and fro movement to the thrust block and with it to the cutter bar. The combined rotary and reciprocating movement thus imparted to the bar gives a chipping and shearing action which effectually prevents the bar from clogging, and the cutters from working into grooves. It also overcomes the defects in bar machines mentioned by the author, should one of the cutters become detached from the bar. The whole gear case being completely enclosed and dust tight, copious lubrication is ensured by partly filling the lower portion with oil. At the outer end of the bar bearing a stuffing box is provided to keep the oil in and the dirt out. The motor is totally enclosed. The starting switch and resistance are also enclosed in a flame-tight cast-iron box bolted to the end of the motor shell. Parts of the shell are made detachable to facilitate handy access to all working parts. The haulage gear is driven by means of a worm gear placed at the end of the armature shaft. This worm gives motion to a cross shaft which passes

through the side of the box, and carries outside a disc with pin, adjustable radially, which operates a connecting rod, and by it the ratchet of the haulage gear. A self-coiling arrangement is fitted to lay the steel wire rope evenly on the drum. Exceptionally large bearing surfaces are provided for all working parts, and the amplest provision is made for free lubrication. All bearing surfaces are so arranged as to be easily renewable. Plate V., Fig. 2, illustrates the working parts of this machine.

There are three methods of mounting a machine for work. First on flanger wheels running on steel rails, second on sledges, and third on flat tread wheels for running on the pavement. The machines can be worked backwards and forwards along the face, and when working there is very little thrust on to the rails or skids.

The usual practice when working longwall, is to cut one shift and to clear away the coal the next. The walls are usually from say 120 to 150 yards in length. If the seam is comparatively level, haulage posts are placed at intervals, and the hauling gear on the machine is regulated to suit the speed of cutting desired. In cases where there is considerable dip in the seam, the machines may be worked by gravity. In this way very long walls have been cut without any stoppage whatever.

The advantages claimed for the "Pickquick" coal-cutting machine are, that the working parts are fewer in number than any other coal-cutter. The machine is very simple, and all the parts have been brought to their present high standard by practical trial and working at the coal face. The complete protection of the working parts is combined with exceptionally convenient means of access for internal inspection, and for the ready detachment and re-fitting of parts. Owing to the gear being machine-cut and enclosed in an oil bath, the machine makes less noise than any other coal-cutter. There are

no bearings or rubbing surfaces under the coal where dust and dirt subject them to excessive wear as in disc and chain machines. The cutter bar is a much simpler apparatus than a disc or chain, and permits of secure and rapid fixing, and easy inspection, and changes of all the cutters. The cutters are of simple make as shown on illustration, and can be sharpened and hardened by any blacksmith. The bar, as previously stated, gives universal cutting. On being swung round in a horizontal plane it cuts its way into the face. It will cut either backwards or forwards along the wall, and the bar can be used at either side of the machine. The bar may also be tilted to suit the rise or dip of the seam, and while working can be raised or lowered at will, and the holding thus made in the best position. Small hitches or faults, undulating pavements, or ironstone balls thus involve little interruption to the continuity of the cutting. The bar always being close to the solid coal cannot be choked or jammed by the coal coming down upon it, and the relatively small end thrust avoids the trouble experienced with disc machines, due to their tendency to push themselves out from the face, thus necessitating jacks, etc., to counteract same.

It will probably be readily allowed that the machine will absorb less power for a given amount of cutting than either disc or chain machines, and furthermore, it has not the tendency to drag the small coal away from the face in amongst its working parts as in those machines.

The diagram, Plate V., Fig. 3, gives particulars of the power absorbed by revolving bar and disc machines holing to the same depth in the same material at a colliery in Great Britain.

The diagram clearly shows the fluctuating demand for power made by the disc machine as against the even running of the bar machine. It might be said that the cutter bar is very liable to injury, but experience has

proved doubts as to the strength of the bar to be without foundation. Damage when working is an exceedingly rare occurrence. The thickness of the cut can be varied from about an average of 5in. to an average of 8in., according to whether the cutters are placed on the tops of the threads or in the grooves of the threads. The smaller cut is generaly used when holing in coal, the larger is used in fire-clay, and other bands where it is desired to destroy the material.

The following examples of work done by the "Pick-quick":—

Colliery	Cutting speed per minute. In.	Depth of Under-cut. Ft.	In.	Lineal yds. cut per shift.	Nature of Holding.
Newbattle Colliery	22	5	0	170	Coal.
Shotts Coal &Iron Colly.	13	4	0	100	Fireclay with Iron Stone.
Law Colliery	20	3	9	120	Coal.
Redding Colliery	19	3	0	172	Black Blaes.

The conditions in different seams vary widely, and for longwall work such questions as the most economical length of face to work, depth to be under-cut, the thickness of the cut, and the relation of speed to the rate of feed, cannot always be pre-determined with certainty, such matters must often be settled by trial and experience.

There is wide and profitable scope for the introduction of mechanical coal-cutters in our coal fields, and it is beyond doubt that machines of proved capacity are now on the market, and available to meet the demands of widely different conditions of employment.

In working thick seams in the older countries, the value of coal-cutters in reducing the cost of production and increasing the value and the amount of the output has been abundantly demonstrated. In medium seams

also, especially where hard holing is encountered, the advantages of machine cutting are widely appreciated. For working thin seams, which are in many cases being perforce resorted to, there is no economical alternative to machine mining. If the holding is to be in coal, the machine will make less small, and if to save coal the holing must be made in the hard strata. The muscle of the hand-pick miner must give place to the machine.

With reference to the particular machine he (the speaker) had the pleasure of bringing forward, in the report of the Committee on Mechanical Coal-Cutting appointed by the North of England Institute of Mining and Mechanical Engineers (published 1903), the "Pick-quick" heads the list in respect of saving in cost of coal getting.

Mr. A. S. Arnot said:—He would like to refer to a part of the paper, where he made rather a strong point, and that is the danger of electrically-driven coal-cutters in gaseous mines. He (the speaker) was rather inclined to agree with Mr. Ferrier with reference to the safety of the electrically-driven motor. The motor could be protected, and the liability of danger reduced to a minimum, so that with the necessary protection there should be practically no risk whatever. The fuses in the circuit could be also protected, so that fusion in the open air could be prevented so far as the mine was concerned. No doubt where gas existed, more expensive cables should be used, but that was not altogether an objection, as the cables would last longer, lead to less loss through leakages, and the plant would be a more serviceable one. Another point was the voltage in electrically-driven motors, 550 volts was mentioned. He thought this excessive. This voltage was quite sufficient, not only to give a man a severe shock, but to kill one. From experience we know that if .03 or

.04 found its way through the body of a man, his blood and the heart action ceased, and he became axpyxiated; and he would likely get a very severe shock. But man, as a rule, has a higher resistance than that, going up as far as 5000 voltages; but in a mine, where air was very damp, and the miner's hands and feet are in a moist condition, he might, with the voltage mentioned, be very severely injured. As a matter of fact, men had been actually killed with that voltage. He would be in favour of fixing the voltage at 200 or 300 in such installations. When men had received a shock to the system in the mine, they became timid, and were apt to do injury to the machinery by neglect.

Mr. R. S. Vincent wished to know if any information as to the relative costs of hand-mining and machine-mining was available; he believed that it is about one-fifth.

Mr. Bragg, in reply said:—He was afraid he had taken a subject that was difficult to discuss by the members not acquainted with coal-mining; but the object of the paper was to bring the matter before them, as the machines seemed to have come to the country to stay. And to those who had not had the opportunity of going down a coal mine, the lime-light views were given so as to show what the machines have to compete with.

The output of the Jeffrey chain machines in the last twelve months had been over 1000 machines. With regard to cutting in the different mines, it was no criterion what the machine did in the mines. One machine might only cut one half as compared with another, still, these machines were found to be economical and a great advantage over hand-picking. Comparisons were nothing to go by. A good deal also depended on the men handling the machines. Mr. Vincent had asked what was the cost compared with hand-picking. It had been reduced as much as one-fifth. He might say that in one or two of the mines where the Jeffrey machines were working, the

information had been voluntarily given that the cost of cutting coal had been cut just in two, that is, half the cost of getting it. Regarding voltage, that was a debatable point. The report of the English Commission was very strict in specifying what should be done with electrical installations in coal mines. They made 600 or 650 voltages the maximum; it was more than 550. He was quite willing to allow 650, but 500 was apt to stick them up a good deal. The danger to life in America was not what would be expected from a high voltage like 550. When there was an accident of the kind it was put in all the papers over the country, and it was pointed out what a terrible thing electricity in mines was. But there were dangers in the mine infinitely greater, such as the fall of walls, roofs, etc., than those to be met with from electricity. The danger was not at the coal face. The motor should be made absolutely sparkless or should be enclosed. There had been a great many attempts with the three phase currents, but that had not been a commercial success. The direct current was the only one that answered. As regards dealing with other and different types of machines, it was quite beyond him. He knew a little about the Jeffrey machine, and one or two other machines, but supposing he had read a paper on other machines or several machines, he was afraid the Jeffrey would have been his favourite. He was interested in the Jeffrey machine, and could not help but favor it. He described the difficulties in using the Pickard mine cutter, especially in a dirty mine, where the cutter required to be raised or lowered to get over hard places. There were hundreds of other points mentioned in connection with the Jeffrey and other machines, but he did not want to make his paper too long or wearisome, and if there were any other points in which members were interested he would be happy to supply them with all other information privately.