temperature at which gasification took place, the greater was the yield of gas and the smaller was the amount of tar formed.

Up to the present coal had been gasified with the object of obtaining the highest yield of gas, but it was quite possible to alter the conditions of carbonization so as to obtain a high yield of fuel oils and other compounds of value as by-products, and an important one was sulphate of ammonia, the use of which as a manure was steadily increasing in all countries of the world. Sulphate of ammonia was the most valuable manure where nitrogen was needed, and it was one of the greatest defects of the crude burning of coal that such enormous amounts of nitrogen were not only wasted, but turned into nitric acid in the atmosphere. Of course, the nitric acid was returned to the soil by the agency of rain, but not necessarily where required by the cultivator.

For one ton of coal gasified in a modern gasworks 11,500 to 12,500 cub. ft. of gas were obtained having a calorific value of about 550 B.T.U. per cub. ft., and also about ten gallons of tar and 25 to 30 lbs. of sulphate of ammonia. The gas had to be purified for domestic purposes; also a gasworks had to be near a great town where the working expenses were not so low as in a more rural part. For these reasons it was doubtful if town gas could be supplied under present conditions for much under 10d. per thousand cub. ft. Despite these facts, Prof. Burstall said he held the opinion after mature consideration, that the whole problem of fuel treatment would lie in the direction of heating the coal, peat or lignite in a closed retort; not necessarily under the conditions which were at present forced on to the gasworks, where the primary object was to produce a big yield of gas of a certain standard as laid down by Parliament. If it be granted that the quantity, quality and purity of the gas produced were a secondary matter, the problem of fuel treatment became one of the most fascinating problems which the engineer could encounter. It had long been known that the quantity and quality of the tar was largely influenced by the temperature at which the fuel was carbonized, the lower the temperature the better were the tars in both yield and composition. The amount of sulphate of ammonia recovered from the gas was only some 25 to 30 lbs. per ton of coal, whereas the amount of nitrogen present in the coal would give about 120 lbs. of sulphate of ammonia. In the ordinary process of carbonization some three-quarters of the nitrogen was left behind in the coke. Under present conditions this could not be avoided, but improvements in this direction were possible. If the gas and tar were withdrawn from the heat directly they were evolved from the coal, a set of products would be obtained of a different composition from those usually obtained.

Prof. Burstall then outlined a scheme of fuel treatment which he admitted was at present wholly beyond the region of practical realization. The first step was to obtain a coal field of wide extent yielding a coking coal, the essential point being to obtain a sufficient supply of coal to enable the capital charge to be repaid in a series of years—probably thirty. The works would have to be on a large scale to economize cost of working, but the carbonization plant would be placed near the pit-head, so that the tubs could discharge direct into the bunkers of the retort-charging machines. A convenient size for each plant would be about 2,000 tons per day, and there would be some five to six pits operating over quite a large area. There would be no gain from any point of view in not shipping the coke and sulphate of ammonia direct from the pit-head, as these would be ready for market without further treatment. Tar and gas would be taken by pipe lines to suitable points for their future treatment, depending upon geographical considerations. The tar from the whole of the works would be passed through continuous and automatic stills, where the various fractions would be obtained with the least expense. The fractions, after working with acid and soda, would pass to a second set of automatic stills, this process being continued until the pure produces ready for market were obtained without the necessity for storage and in the least possible time. As to how far the treatment of residuals should be carried, no definite answer could be given, as it depended on the current prices, but on the scale considered, viz., 120,000 to 140,000 gallons of tar per day, it would certainly be advantageous to treat the products to a finish.

That portion of the gas not required for firing the automatic stills and for colliery purposes generally would be led to a different point, perhaps many miles from the pit-head. This offered no difficulty as regards the power required, the great obstacle being the cost of the pipe line, which might to a large extent be reduced by gasholders at the delivery end so as to improve the load factor on the pipe line. The gas would be free from tar, but would contain the sulphur compounds, and would be employed in gas engines for the generation of electricity at high voltages.

No doubt electrical engineers would look askance at gas engines, not only from the many failures that had occurred with some of the large engines, but also at the fact that at present some 2,000 h.p. was about the largest size that could be built, whereas a steam turbine could be constructed to give an output of 20,000 kw. at a low first cost. The gas engine could only compete with the steam turbine when its gas was delivered to it at a price which, when helped by its high thermal efficiency, would enable it to recoup its large capital outlay. But perfect as was the steam turbine as a mechanical machine, its thermal efficiency was half that of its rival, as the cost of the steam delivered to it could not be reduced. There were also no by-products. For these reasons it was quite possible for the gas engine to produce current more cheaply than the turbine, but the price of gas of a calorific value of 500 B.T.U. per cub. ft. would have to be 4d. per thousand cub. ft. if coal be taken at 20s. per ton. This would give for each fuel about 125,000 B.T.U. per penny, and taking the gas engine as 2½ times as efficient as a turbine, this should leave enough margin to compensate for the increased capital outlay. The exhaust gases would be washed so as to extract the sulphuric acid, which would be returned to the pit-head in the manufacture of sulphate and the washing of the tars, so that the only external material to be purchased would be the soda ash used to neutralize the excess acid. In this manner the whole of the products of the coal would be recovered in a form ready for the market, and if the coke were used as a domestic fuel a smoke-laden atmosphere would be impossible.

Producer gas for power and heating purposes had a large field in front of it, particularly when the factory was distant from the coal fields, and also where there was a steady load. In producer gas the whole of the fuel was converted into gas and tar, so that a large quantity of gas—120,000 to 140,000 cub. ft.—could be obtained per ton of coal. The ammonia yield was very high, being 80 to 90 lbs. of sulphate per ton; the calorific value of the gas was low, about 140 B.T.U. per cub. ft., and the tar was small in quantity and poor in quality, as it was nearly all pitch. The low calorific value and the difficulty of cleaning the gas were serious drawbacks to the transmission over long distances. In South Staffordshire, how-