nection with the working and maintenance of producer gas plants were not insurmountable, and doubtless would in time be overcome. The adoption of producer gas by manufacturers and electric supply corporations was steadily increasing, and engineers would do well to study a system that was closely allied to general engineering work. Gas and electricity were usually looked upon as rivals, but they were more closlly associated than was generally acknowledged.

In the early days of electric lighting in this State, gas engines were much in favor for small electric light plants, but with the advent of central stations the gas driven plants were doomed for a time.

The electric arc was used in the manufacture of carbide of calcium for acetylene gas, and gas was now used for the generation of electricity.

He had just received a letter from our old and esteemed friend, Mr. Lee Murray, who was engaged in erecting for the Johannesburg Municipal Electric Lighting and Power Supply, the first contract consisting of:—Five 2000 h.p. two-phase, 2000 volt alternating and three 1000 h.p. 550 to 600 volt continuous current generators, 13,000 h.p. in all, to be driven by slow-speed gas engines.

The Reading Electric Supply Company had recently erected two 500 K.W. producer gas, William Siemens Dynamo plants to cope with the increasing day load.

Gas Plants were also used by the following Electric Supply Authorities:—"Ryde (Isle of Wight), Northwich" Redditch and Walthamston. He was credibly informed that producer gas was being piped by the Mond Gas Coy. and sold at 2d. per 1000cb-ft. The advantage of a cheap power and heating gas obtained in this way would no doubt be readily availed of by all classes of manufacturers ,and the use of small isolated gas

plants with their inherent troubles would thus be avoided.

Mr. Arnott quoted data from the "Electrical Times" in defence of Steam driven plants. The Power Gas Corporation Ltd. of London, also published data of Costs of Fuel per unit of Electricity sold, being averages taken from 167 Central Stations (Steam) in the United Kingdom (abstracted from the Electrical Times Dec. 4th. 1902).

The average Cost of Fuel for the 167 stations—0.952 pence per unit sold equivalent to about 0.809 pence generated.

A comparision was made with gas engines running continuously at Winnington. The actual cost for Mond Gas was stated to be 0.048 pence per unit generated.

This figure appeared to be abnormally low and was not borne out in practice as far as the four Stations, referred to, were concerned. The cost per unit sold being as under:—

	Fuel.	Works.	Total.
Ryde	0·92 pence	2·79 pence	5·19 pence
Northwich	0·48 ,,	1·55 ,,	2·47 ,,
Redditch	0·88 ,,	1·84 ,,	2·25 ,,
Walthamston	0·46 ,,	1·07 ,,	1·31 ,,
Average	0·68 ,,	1·81 pence	2·80 pence

per unit sold. (*The Electrical Times*, July 27, 1905).

The fuel and other cost were however, sufficiently low to command the respect and attention of engineers.

Mr. E. Forkel, in reply said it was very gratifying to him to see that his paper had apparently been of interest to the Association, judging by the lively criticism it had evoked from the advocates of steam power,

and also by the support accorded to it by some other members. He desired to thank them all, for throwing light upon the subject, and more especially Mr. Kilburn Scott, for his valuable evidence based upon his own observations with Suction Plants in actual work.

In replying to his critics, he would confine himself to proving those of his points that had been assailed, and to removing misconceptions that had taken place.

Some suggestions made, and questions asked him, might form interesting material for another paper, but they were hardly within the scope of strictly logical criticism, for the simple reason that he had not dealt with them in his paper.

We had been told that the Frenchman Beau de Rochas, and not Dr. Otto had invented the four-cycle principle. It was undoubted that Rochas had worked it out in theory, and had tried to prove his theory on paper before Otto gave his motor to the world; it was equally true that a four-cycle motor had been actually built by Reithmann, a watchmaker of Munich, even before Rochas committed his ideas to paper. But neither of these men saw or recognised the value of this principle, and had it not been for the fact that the "Deutz" Motor Works had to fight for their monopoly inthe Law Courts, in the Seventies, these two names would never have been known to the Engineering world.

Dr. Otto was the man who gave this principale to the world, and it was he who was entitled to be looked upon as the father of it, and not the men who stumbled across a principle, the value of which they did not recognise. If the laurels were not due to Dr. Otto, then we must also remove the name of James Watt as the inventor of the steam engine, because he was preceded by Papin, and Papin by Lonhard de Vinci.

George Stephenson would lose his title as the inventor of the locomotive for the same reason, having been preceded by Trevithick and Blenkinsop. Furthermore Hero of Alexandria constructed a steam turbine before the christian era; was he the inventor of the steam turbine? Watt brought out the first practical steam engine, and Stephenson with his reversing gear gave to the world the first practical locomotive, just the same as Otto gave us the practical four-cycle engine, and for that reason they all three were entitled to be named as first inventors.

Mention has been made by some of his critics that the automatic nature of the Suction Producer under review, made the gas production uncontrollable, which carried in its trail all sorts of imaginary difficulties. Every designing engineer made an effort now-a-days to construct his engine as much as possible on automatic principles so as not to court failure through negligence and incompetitent attendance, to say nothing of the financial saving in dispensing with skilled labor.

The fact that it was not necessary to employ a skilled engineer to attend to the Suction Gas Producer was one of its strong features, yet it was pointed out as a disadvantage, Skilled engineers were certainly always employed at the extensive installations such as Electric Lighting Stations, Water Works, etc., but with ordinary plants this is quite superfluous, and with small ones it would simply be disasterous in competition with City gas and steam plants. Nay, such a suggestion was against all reason and business principle, and a satire on the high standing of engineering science.

Regarding the failure of many Suction Producers as cited, it was necessary to point out that the "Deutz" Works had up to May last supplied 8,900 installations

(from 6 H.P. to 600 H.P.) that were working without a hitch. No less than 2,200 flour mills were supplied with Suction Producers, and they were running day and night without skilled engineers looking after them.

That the steam engine would under certain conditions answer more quickly to a sudden increase in load was freely admitted, but it was a fact for all that, that Suction Gas Producers were being used in the timber, textile and paper industries, at electric stations, water works, breweries, engineering establishments, iron rolling mills, etc., and it would surely not be asserted that there was no varying load in all these.

Regarding the question as to how the generator answered under a varying loads, he wished to state that the variations are imperceptible if the changes of—say—from a quarter to full load and vice versa took place at reasonably short intervals. This was brought about by the fact that the generator was kept in a well heated condition, although the gas production varied with the load. If, however, it so happened that the Plant had been running with the very light load or none at all for—say—half an hour longer, it would probably take up to ten minutes before it would carry the maximum load, because the incandescence of the coke had been reduced and the generator cooled in proportion.

The following are some examples :—

The Steel Works (Hoesch) at Dortmund employ two 300 H.P. engines driven by blast furnace gas. The management reports that with a sudden change of load from 200 to 400 amp. or vice versa, the tachometer variations are hardly perceptible. The Iron Works Duedlingen, employ two Engines of 600 H.P. each, and and two 1000 H.P. each to drive the dynamos of their Electric Power Station. These engines had been running 22,185 hours up to July 1902 at the rate of from

14 to 20 hours per day. The high degree of uniformity of speed permitted of the Motors being easily paralleled and a perfect synchronism was thus obtained. The starting and paralleling occupied about three minutes. A further proof of the excellent regulation of these Motors was the fact that they had been coupled direct to heavy roller systems in which the load varied very considerably.

Doubt had been cast upon the accuracy of his (the Author's) calculations as to cost of attendance. In reply he wished to state that the figures given represented actual figures, and he had only increased the cost by altering the wages to suit the conditions prevailing in this country. The fire in the generator was not necessarily drawn every evening, but it would smoulder away during the night similar to the Anthracite in the perpetual stoves that were kept alight during the whole winter in cold countries. A slight application of the fan in the morning after a good raking would, with a replenished hopper soon have the generator in full working condition. In large installations it was usual to employ an electric motor to drive the fan, so that even that small amount of labour was dispensed with. Connecting or disconnecting the generator with the scrubber and engines required only the turning of the weighted lever. The daily cleaning of the tar-extractor was not a laborious task either, since the dirty one was simply thrown into a vessel containing benzine, and left there.

It followed that even this class of labour would take up a certain amount of time, but since no special skill is required, it smiply amounted to the acquisition of knack to do it expeditiously. For actual results, he could only refer to a country that was foreign to them, and he had preferred to supply estimates (though they might be only stimates) based upon our own local con-

ditions, because he held that to be more palatable to them. He would now quote a few figures concerning the subject of his paper, for the edification of those who were sufficiently interested in it:—

Cohn Bros., Reichenberg.—120 h.p. gas engine, driven by Suction Producer; working 10 hours per day; load 120 h.p. to 130 h.p. Consumption of coke 1,100lbs, equal to .88lbs, per h.p. hour. The plant was attended to by one man. It required forty-five minutes to generate sufficient gas to drive the engine, if a fresh fire was to be started in the morning, but only fifteen minutes if the fire had been kept smouldering over night. This plant was erected with a guarantee from the manufacturers as to the consumption of fuel, in consequence of which accurate tests were made, and the figures were absolutely reliable.

W. Schickert & Sons, Munich.—This firm employed an "Otto" gas engine, of 16 h.p., and the average monthly gas account was £16 sterling—£192 per annum. They were persuaded by "Deutz" to produce their own gas, and the result was simply astounding, inasmuch as the cost fell to £2 10s. per month—£30 per annum. The generator was attended to by one of the workmen.

Iron and Enamel Works, Neusalz.—The test was instituted in November, 1903, between an 80 h.p. engine, driven by suction gas, and an 80 h.p. compound portable engine, with condenser built by R. Wolf, Madgeburg-Bukau.

Gas.—293 hours, 70 h.p., equals 20,510 h.p. hours, Consumption of coke 23,210lbs., equals 1.13lbs per h.p. hour. (The coke was kept smouldering all night). The total cost, including fuel, labour, and attendance, but without providing for sinking fund, was £13 19s per month, equal to .17 of a penny per h.p. hour.

Portable Engine.—266 hours, 84 h.p., equals 22,344 h.p. hours. Consumption of coal 51,700lbs., equals 2.3lbs.

per h.p. hour. The total cost, including fuel, lubrication, and attendance, but without providing for sinking fund, was £23 5s 8d, equal .25d per h.p. hour.

Further proof of the superiority of Suction Gas Producers was supplied by statistics published by the official organ of the German Electric Works and Stations, though their figures are in opposition to those supplied by Professor Leviki. The average efficiency of steam driven electric plants was given as 425 h.p. That of the Producer gas driven one was 480 h.p. The ages of the compared systems were given as 5.2 years for steam, and 3.8 years for gas engines. Average work of steam plant 4.58 hours per day, with 80 per cent. load. Average work of gas plant 3.25 hours per day, with 80 per cent. load. The former had a clear advantage here as compared with the latter. Statistics showed that in the steam plant one cal. of the fuel (3,968 B.T.U.) would produce .053 watt hours. The gas plant under same conditions would produce .12 watt hours. We see clearly here, that the efficiency in the Suction Plant was more than double that in a steam plant, in spite of unfavourable conditions with regard to time as well as load. The labour entailed in cleaning the entire plant was given by the Waterworks of Kupferdreh, as follows:—

Plant.—100 h.p. running 9 hours per day; stoking twice a day, 15 minutes each, equals 30 minutes; refilling hopper every two hours, 10 minutes each, equals 45 minutes. Cleaning: Piston every 3 months, time 5 hours; gas valve every 8 days, time 1 hour; other valves every 2 months, time 5 hours; ignition box every 8 days, time 1 hour. Unusual wear and tear was not noticeable after running two years.

It is not necessary to change the coke in the scrubber every week, as suggested, since it would last for from nine to twelve months. There was certainly no-

thing to stop it being dried and burnt in the generator, but it seemed too trivial to bother about.

In the paper he had quoted figures in connection with his estimate for running a steam plant, which were held by his critics as being too low. He freely admitted the impeachment, and merely wished to state that the figures referred to correspond with those given in Dawson's Engineering and Electric Pocket Book.

His critic was here confusing the present producer with the suction producer. The latter being under less than atmospheric pressure, could only admit air during stoking operations, but never eject any gas.

He had always been under the impression that the particular style of generator under review was designed by "Deutz," but he would make enquiries at headquarters and report in due course.

25 H.P. Engine Supplying 32 H.P.—Replying to this question he desired to state that the 25 h.p. was nominal, and the 32 h.p. was break.

No one had assailed the principle of the Suction Gas Producer, but simply structural details. Some of the objections he hoped to have dissipated with the assistance of those of our members who had supported his contention during the discussion. Further improvements as foreshadowed by some of our members, would undoubtedly follow if experience found them necessary. There was no room for doubt, that the Suction Producer Plant beat the steam plant by nearly two to one in the efficiency obtainable from fuel, and this was the cardinal point of the whole controversy.

The Suction Producer Plant has achieved within the few years of its existence, what the steam plant had failed to do in a century, and we were only stan-ding in our own light as progressive engineers, if we failed to recognise so vital a principle.

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