PROCEEDINGS

OF THE

SECOND CONVENTION

OF THE

Association of Municipal Electrical Engineers

(UNION OF SOUTH AFRICA)

Held at Durban, South Africa,
From Monday, August 27th, to Friday, August 31st
1917.

[PRICE FIVE SHILLINGS]

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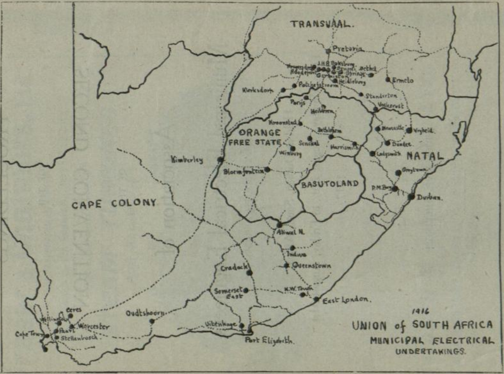
TRANSVAAL.
Pretoria
Ermelo
Potchefstroom
Heidelberg
Klerksdorp
Standerton
Volksrust
Heilbron
Kroonstad
ORANGE
FREE STATE
Senekal
Bethlehem
Winburg
Harrismith
Newcastle
Vryheid
Dundee
Ladysmith
NATAL
Kimberley
Bloemfontein
Greytown
BASUTOLAND
P.M.Burg
Durban
CAPE COLONY
Aliwal N.
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K.W. Town
East London
Ceres
Oudtshoorn
Worcester
Paarl
Cape Town
Stellenbosch
Uitenhage
Port Elizabeth
1916
UNION of SOUTH AFRICA
MUNICIPAL ELECTRICAL
UNDERTAKINGS.

A. S. Munro (Pietermaritzburg). R. A. Stoker (Kroonstad). G. H. Swingler (Cape Town). C. J. Everatt (Johannesburg). Councillor Hooper (Cape Town). P. J. Gold (Benoni).

T. Millar Harrismith). Councillor Gilbert (Harrismith). H. Brittle (Cradock). (Member of Council) T. Jagger (Ladysmith). Councillor Francis (Bethlehem). Councillor Hudson (Port Elizabeth). M. McDonough (Bethlehem). (Member of Council) G. A. Stewart (Bloemfontein). Councillor Payne (Durban).

Councr. Crawford (Bloemfontein). (Hon. Sec. & Treas.) E. Poole (Durban). (Members of Council) T. C. Wolley-Dod (Pretoria). Col. Dobson, D.S.O. (Johannesburg). (President) J. Roberts (Durban). (Vice-President) B. Sankey (P. Elizabeth). (Member of Council) W. Bellad-Ellis (Queentown). Councr. Bischoff (Pretoria). W. H. Blatchford (Greytown).

MEMBERS AND DELEGATES AT THE DURBAN CONVENTION.

INDEX.

PROCEEDINGS

OF THE

Association of Municipal Electrical Engineers

(UNION OF SOUTH AFRICA.)

FOUNDED 1915.

EXECUTIVE COUNCIL:

President:

JOHN ROBERTS (Durban).

Vice-President:

B. SANKEY (Port Elizabeth).

Members of Council:

Past President: COL. F. H. DOBSON, D.S.O. (Johannesburg).

CAPE PROVINCE: W. BELLAD-ELLIS (Queenstown).

ORANGE FREE STATE: G. A. STEWART (Bloemfontein).

TRANSVAAL: T. C. WOLLEY-DOD (Pretoria).

NATAL: T. JAGGER (Ladysmith).

Hon. Secretary and Treasurer:

E. POOLE (Durban).

RULES AND CONSTITUTION

OF THE

Association of Municipal Electrical Engineers

(UNION OF SOUTH AFRICA).

As submitted and passed by the full meeting of the Association held at the Town Hall, Johannesburg, on Friday, November, 1915, with amendment (item 6) as submitted and passed at the Durban Convention, 1917.

---

1. TITLE.—The Association shall be called the Association of Municipal Electrical Engineers (Union of South Africa).

2. OBJECTS.—The objects of the Association are to promote the interests of Municipal electric undertakings.

3. MEMBERS.—Members of the Association shall be Chief Electric Engineers engaged on the permanent staff of an electric supply or tramway undertaking owned by a local authority in the Union of South Africa, and any duly qualified assistants whom they may recommend for election. Should any member cease to hold his qualifications as above, his membership shall cease.

4. CONTRIBUTIONS OF MEMBERS.—The subscription shall be £2 2s. for Chief Engineers and their Chief Assistants and £1 1s. for other members.

5. OFFICERS.—The Officers of the Association shall consist of:—President, Vice-President, Hon. Secretary, and the Hon. Treasurer.

6. COUNCIL.—The Council shall consist of the President, Vice-President, the two immediate Past-Presidents, and four members to be elected at the Annual Congress.

7. ELECTION OF OFFICERS AND COUNCIL.—Officers and Members of Council shall be elected by nomination and ballot at the Annual Congress, and shall hold office until the next Congress.

8. All those who attended the Congress in Johannesburg in November, 1915, shall ipso facto be members of the Association.

9. ELECTION OF FUTURE MEMBERS.—The election of future members of the Association shall be vested in the Council.

10. The affairs of the Association shall be managed by the Council, who shall have power to incur any expenditure necessary for the objects of the Association.

11. The voting at the Congress shall be restricted to the members present at such Congress.

12. The financial year of the Association shall terminate on the first day of the Annual Congress, at which date all subscriptions for the ensuing year become due, and no member will be allowed to vote whose subscription is in arrear.

13. PRESIDENT.—The President shall take the Chair at all meetings of the Association, the Council, and the Committees, at which he is present, and shall regulate and keep order in the proceedings.

14. In the absence of the President it shall be the duty of the Vice-President to preside at the meetings of the Association, and to regulate and keep order in the proceedings. But in the case of the absence of the President and of the Vice-President, the Meeting may elect any Member of the Council, or in the case of their absence any Member present to take the Chair at the Meeting.

15. The local Press of the town in which the Congress is held shall be notified of the time and date of the reading of all papers, but the Association shall reserve to itself the right to resolve itself into Committee at any time during its proceedings; moreover, it shall be competent for any Member to have his paper read and discussed in Committee if he so desires.

16. The Honorary Secretary and the Honorary Treasurer shall present a yearly report on the state of the Association, which shall be read at the Annual Congress.

17. The Honorary Treasurer shall be responsible for the funds of the Association, and shall present a Balance Sheet at the annual Congress.

Association of Municipal Electrical Engineers

(UNION OF SOUTH AFRICA).

SECOND ANNUAL CONVENTION,

DURBAN, AUGUST, 1917.

Programme of Proceedings.

MONDAY, 27th, 10 a.m.—Welcome by the Mayor and formal opening of Convention.
Valedictory address by Retiring President.
Election of officers, etc., and other formal business.
1 p.m.—Luncheon at the Royal Hotel by invitation of the Mayor.
3 p.m.—Visit to Messrs. Lever Bros.' Soap Works.

TUESDAY, 28th, 10 a.m.—Meeting: Presidential address; "Tariffs" discussion and reply.
2.30 p.m.—Visit to Power Station, Car Sheds, and Municipal Telephone Exchange.
8 p.m.—Meeting at Technical College with local engineers, on "South African Municipal Electrical Undertakings."

WEDNESDAY, 29th, 2 a.m.—Journey to Pietermaritzburg.
10 a.m.—Lecture on "Railway Electrification."
12 noon—Visit to Power Station and Car Sheds.
1 p.m.—Luncheon at Imperial Hotel by invitation of the Mayor.
3 p.m.—Motor trip round the city.
7.30 p.m.—Arrive in Durban.

THURSDAY, 30th, 10 a.m.—Meeting: "Standarisation" and discussion.
2 p.m.—Continued discussion.
8 p.m.—Dinner with local engineers.

FRIDAY, 31st, 10 a.m.—Meeting: Resolutions on Profits; "Small Power Stations" and discussion.
General business.
2 p.m.—Visit to Natal Sugar Estates.

PROCEEDINGS

OF THE

SECOND ANNUAL CONVENTION

OF THE

Association of Municipal Electrical Engineers

(UNION OF SOUTH AFRICA).

Durban, August 27th to August 31st, 1917.

MONDAY, AUGUST 27TH, 1917.

Introductory.

The second annual Convention of the Association of Municipal Electrical Engineers (Union of South Africa) was opened at Durban on August 27th, 1917, the proceedings being held in the Council Chamber, Municipal Buildings.

Members Present:—Colonel Dobson, D.S.O. (Johannesburg), in the chair; John Roberts and E. Poole (Durban); W. Bellad-Ellis (Queenstown); G. H. Swingler (Capetown), M. McDonough (Bethlehem); G. A. Stewart (Bloemfontein); R. A. Stoker (Kroonstad); T. Jagger (Ladysmith); T. Millar (Harrismith); W. H. Blatchford (Greytown); P. J. Gold (Benoni); H. Brittle (Cradock); A. S. Munro (Pietermaritzburg); and B. Sankey (Port Elizabeth).

Delegates Present:—Councillors J. Wilson (Standerton); E. Hopper (Capetown); S. G. Francis (Bethlehem); J. Crawford (Bloemfontein); J. Lawrence (Kroonstad); E. W. Gilbert (Harrismith); C. Bischof (Pretoria); Smith Hudson (Port Elizabeth); S. Carter (Greytown); and G. A. Payne (Durban).

Civic Welcome.

Before the official proceedings were opened, the Mayor of Durban (Mr. J. H. Nicolson, J.P.) attended the Convention and extended to the members and delegates an official welcome on behalf of the Borough. He said that Durban was delighted to see them there, and he trusted that they would have an exceedingly pleasant time and that their discussions would profit the various boroughs and towns they were representing that day. The Mayor added that Councillors were in the hands of those gentlemen present there who were experts and had made the profession of electrical engineering their life study and their life's work. The real tests of an undertaking were the results that were given. Durban was rightly proud of its tramway service and their electrical undertaking, thanks to the excellent work of Mr. Roberts, for he thought there was something which even the more advanced municipalities could learn from Durban.

The President thanked the Mayor of Durban on behalf of the Convention for the hospitality which was being extended to them.

VALEDICTORY REMARKS BY THE RETIRING PRESIDENT, COL. J. H. DOBSON, D.S.O.

Gentlemen,—

On behalf of your Council I extend to you all a cordial welcome to this, the second annual Congress of the Association of Municipal Electrical Engineers of South Africa. More especially do I welcome those Councillors, the representatives of the public in the various towns of South Africa, who have taken, and are taking, such an interest in their respective Municipal undertakings as to honour us by their presence at this Congress. I sincerely hope that when the Congress has terminated they will feel, as I am sure they will feel, that their visit has been of some benefit, not only to themselves, but to the Municipal undertakings they represent.

Since our last meeting in November, 1915, the world-war has continued with possibly greater ferocity than in the earlier stages, and we are still in the throes of the greatest slaughter in history.

The inventive genius and the highest scientific attainments of mankind are being utilised for the destruction of human beings, and also for the destruction, more particularly in Europe, of everything which marks our present stage of civilisation, but we are still hoping that out of the awful misery and gloom of this great struggle between Military Despotism and Democracy a new era will soon dawn upon us when armaments for the destruction of our fellow-beings shall be no more, and the latent talent of the many heroes, which has been discovered under conditions of warfare, and the results and lessons arising from our Herculean efforts in fighting for freedom and liberty, will be applied to the arts of Peace, for the evolution of man, and for the upward march of civilisation.

The war has brought about many changes in the engineering world, and in accordance with the law that "necessity is the mother of invention" enormous progress has been made in almost every branch of industry, in which engineering in these days plays such an important part. Standardisation and combination of interests and the conservation of the sources of energy are factors which will revolutionise engineering as we now know it, when human skill is devoted to a policy of construction as against the present debacle of destruction.

Our Municipal Association of Electrical Engineers has representation on the South African Standards Committee, and it is pleasing to report that good work is being done so far as South Africa is concerned, and, as Mr. Roberts has to deal at length with some problems of Standardisation during the week's Congress, I will not say more on the question of standardisation.

Combination of interests and the conservation of, or more efficient uses of, our sources of energy are factors in which the engineer will play a very important part. Referring in particular to the Municipal Electrical Engineer, the necessity for the conservation of coal in Great Britain has lead to an enormous progressive movement in the linking up of the various power stations in the counties, and the smaller towns will have the advantage of cheaper power supply, while the bigger towns are benefiting by the greater output and the better load conditions owing to the diversity factor of the individual requirements of the numerous towns now linked together. The next step froward will undoubtedly be that the counties will be linked together, and, following in its trail, let us hope a completely electrified Great Britain. Great Britain is relatively a small place. Those of you who have heard the description by Mr. Kirkland, of the electrification of the Chicago, Milwaukee and St. Paul Railway in America, 440 miles long, and have become acquainted with its successful operation (more especially from the engineering point of view), must have been struck with the possibilities of the future.

The length of industrial Great Britain is not more than 400 miles, and it would not be too prophetic to predict the possibility, in the near future, now that the town and city supplies of Great Britain are being linked together to form county supplies, that the county supplies will be the forerunner of national supplies of electricity from power stations situated at the great coal fields, with 50,000 K.W. and possibly 100,000 K.W. generating sets supplying power to the whole of the railways in Great Britain, and the whole of the country reticulated with power supply mains and a cheap power supply to every part of the country radiating from the different sections of the railways. (What a blessing it would be for the industries of the country!) The war has opened our eyes to expenditure of thousands of millions of pounds. It has broadened our ideas, and, in order that Great Britain shall occupy one of the first places in the industrial world, it might pay the Government to embark on a scheme of National Power Supply on the lines just briefly outlined. Existing power station plants might be sold in different parts of the world where they would be useful. The industrial progress which would follow and the saving in coal alone, and the recovery of some of the important by-products of coal, when worked on such a large scale, and the sale of the existing plant when same could be released, would possibly not only justify the scheme, but would enable vested interests to be satisfactorily dealt with. Such are the possibilities of the future for the electrical engineer.

To turn more closely to affairs in South Africa. The greater distances here preclude such possibilities, at any rate in our time. At the same time we should attempt to apply the best progress here, where there are economic possibilities In this connection one cannot avoid referring, however briefly, to the question of the electrification of some sections of the South African Railways, and it is satisfactory to have heard the remarks which fell recently from Sir William Hoy, the General Manager of the Railways, that the Government intend to tackle this question seriously, and in this respect it is more than probable that the electrification of the Johannesburg-Durban main line section will receive a fair share of consideration. The distance between Johannesburg and Durban is about the same length as the electrified railway of the Chicago, Milwaukee and St. Paul Railway, the satisfactory running of which has been so fully demonstrated by Mr. Kirkland. The high cost of labour for maintaining mechanical equipment in this country and the high cost of wearing parts, the narrow gauge and the steep grades, the sharp curves and dense traffic, as well as the difficulties of picking up water, and the presence of cheap coal which may be utilised in our power stations but not in locomotives, are all factors which affect the financial position and lend themeslves to the electrification of railways. In this respect Durban is destined to play an important part, as being the tail-end of the section of the railways just referred to, and Mr. Roberts can be relied upon to give the best advice to his Council as well as to the Railways concerning the best possible means of providing a cheap power supply for the end section of the Johannesburg-Durban line under such conditions as will suit the Railways, and, possibly to the benefit of Durban, at the same time, by the greater output.

The Durban Power Station is already of a size that it can seriously undertake the question of power supply to the end section of the railway. The load is such that it would probably not pay the Railways to run a station of its own, and the capital would, therefore, be better invested in the existing Municipal station at Durban when the question of electrification is seriously taken in hand.

The programme for the week's Congress indicates there is plenty of work before us, and it is hoped that there will be time to consider the standardisation of Electricity Supply Bye-Laws, Wiring Regulations, and the question of Licensing of Electricians.

During my tenure of office as your first President, I was for over twelve months on active service, and it is only due to exceptional circumstances that I have unexpectedly returned to civil duties for the time being and that I have the pleasure of being amongst you at this the second Congress. In feeling and expressing my regret that during my tenure of office as President I have not done considerably more for the Association, due to my having been on military service, I have to express my thanks and high appreciation to your Council and the Secretary and the Treasurer for the work they have accomplished. More especially do I think the thanks of the Association are due to Mr. Sankey, who undertook the secretarial duties during the last twelve months, and to whom the excellent arrangements for this week's Congress are very largely if not entirely due.

In handing over the Presidential chair to Mr. Roberts, the Municipal Electrical Engineers of South Africa are honouring one of the most progressive electrical engineers in South Africa, and the status and dignity of the Municipal Electrical Engineers' Association will be safe in his hands, as we know him to be a devoted and conscientious worker in all matters pertaining to the electrical engineering profession and more particularly in all work which falls immediately under that of Municipal Electrical Engineers. We shall look forward with interest to the reading of his Presidential address, as well as his paper on Standardisation, which will form subjects for careful study and discussion for the benefit of Municipal undertakings in South Africa.

I will now call upon the Secretary to read the reports of the Secretary and Treasurer.

HON. SECRETARY'S REPORT.

Mr. Sankey (Port Elizabeth) then presented the following reports of the work of the Association from August, 1916, to August, 1917:—

Mr. President and Gentlemen,—

In accordance with Rule No. 6 of the Rules and Constitution of this Association, I have pleasure in submitting a report to the members covering the period during which I have held office.

As notified to members in a circular letter dated August 26th, 1916, our Secretary, Mr. Stokes, finding it impossible in the absence of the

President (Lieut.-Colonel Dobson) on active service, to carry on the duties, I volunteered to assist, and, at the request of Mr. Stokes and with the approval of your Council, took over the whole of the secretarial duties.

Having drafted the Proceedings of the Association, it was found that the funds available were insufficient to enable them to be printed. It became necessary, therefore, to delay publication until ways and means could be found.

Eventually, by obtaining a number of arrear subscriptions and the addition of several new members, publication was made. I have also to express my thanks to a number of members for their support in purchasing extra copies for distribution, and I am pleased to be able to state that by these various efforts the funds of the Association have been placed in a satisfactory position, as the report of our Treasurer will show.

Of the various activities of our Association during the past twelve months I have little to say here, as members have been circularised from time to time with a view to keeping them fully informed and maintaining their interest in their own Association. One of the most important matters which has been dealt with is that of "Standardisation," which will be before members during the Convention. It is, however, a matter of regret to me that in the case of a large majority of members so little interest appears to be taken. Letters and circulars appear to be, in many cases, entirely ignored, and I would earnestly enjoin members that it requires individual and collective effort and interest to maintain the importance and value of our Association to the honourable profession of the Central Station Engineer and the status that such a profession should carry. It has been the object of your Council and Secretary to bring together this year both Engineers and Councillors with a view to a mutual interchange of ideas, knowledge, and experience, in the hope that Councillors and Engineers will return from the Convention with broader and more tolerant views of their respective spheres, to the mutual advantage of Municipalities and their Engineers, and that these views will be in turn conveyed to the Councils and Committees represented.

It is satisfactory to note that an appreciable number of Councils are sending Councillor delegates, and it is to be hoped that in future, and under more favourable circumstances, it will be the rule rather than the exception.

As regards the state of our Association, I feel, as your Secretary, that we have made satisfactory and substantial progress since our first Convention at Johannesburg in November, 1915. At July 31st, 1917, there are thirty-one members. During the last twelve months four members have resigned, three of these having resigned their appointments and left municipal employment, whilst nine new members have been elected. One of our members, Mr. L. B. Proctor, of Boksburg, is away on active service.

During the period under review, Mr. T. C. Wolley-Dod (Pretoria) has been added to the Council to fill the vacancy caused by my appointment as Secretary, as will be seen from the list given in the Convention programme.

There are still a few undertakings not represented, and members are urged to advise the Secretary of any possible new members.

With the commencement of the Durban Convention my term of office as your Secretary comes to an end, and I desire, in conclusion, to thank the President, Members of Council, Treasurer and late Secretary, as well as other members, for the active co-operation and assistance which they have given to me in carrying out my duties.

B. SANKEY, Hon. Secretary.

HON. TREASURER'S REPORT.

In accordance with Clauses 16 and 17 of our Rules and Constitution, I have pleasure in submitting a statement of receipts and expenditure of our Association from the date of its inception in November, 1915, to the present date, and also balance sheet as at this date.

You will be pleased to note that although the Association has had in reality the equivalent of only one year's operations, we are in the happy position of having a credit balance of over £30. In this connection I feel it my duty to state that in my opinion this very satisfactory and, may I say, unexpected position, has been brought about almost entirely through the untiring efforts of the Hon. Secretary, Mr. Sankey, in bringing the objects of the Association before all the Municipal Electrical Engineers in the Union. I purposely use the word "unexpected," as at the time Mr. Sankey took over the secretaryship in August, 1916, the then available funds were insufficient to cover the cost of printing the proceedings of the 1915 Congress.

There is one outstanding subscription, that of Mr. L. B. Proctor, who is on active service in Europe, and I would suggest that in accordance with the procedure adopted by other institutions this subscription be remitted.

Now that the financial affairs of the Association are on a stable basis, the question of opening a separate banking account in the name of the Association should be given consideration.

As I am unfortunately unable to attend this year's Congress in Durban, I take this opportunity of wishing you a successful week and of expressing my willingness to do anything within my power to further the objects of the Association in the future.

E. T. PRICE, Hon. Treasurer.

RESUME OF TREASURER'S ANNUAL STATEMENT
For period ending 10th August, 1917.

(Treasurer, Mr. E. T. Price.)

To save paper and labour, the following resume is given of the above statement:—

REVENUE AND EXPENDITURE ACCOUNT.

INCOME.

	£	s.	d.
34 Subscriptions at £2 2s.	£71	8	0
Sale of extra copies of Proceedings	8	2	0
	£79	10	0

EXPENDITURE.

	£	s.	d.
Clerical assistance to August, 1916	£10	0	0
Printing and stationery	31	18	6
Photos for Home papers	0	15	0
Postage and receipt stamps	6	0	4
Balance carried to Balance Sheet	30	16	2
	£79	10	0

The Balance Sheet shows Liabilities and Assets balancing £30 16s. 2d.

The whole is duly certified as being correct by Mr. H. D. Percival, accountant, Johannesburg Municipality.

Moved by Mr. McDonough (Bethlehem), seconded by Mr. Bellad-Ellis (Queenstown): "That the reports of the Secretary and Treasurer as read be adopted, and that in regard to the outstanding subscription of Mr. L. B. Proctor, of Boksburg (on Active Service), the subscription be remitted."

Adopted.

Election of President.

Moved by Mr. McDonough (Bethlehem), seconded by Mr. Stoker (Kroonstad): "That Mr. John Roberts be elected President of the Association for the ensuing year."

There were no other nominations, and the retiring President declared Mr. Roberts duly elected as President. In quitting the Chair, Colonel Dobson remarked on behalf of the Association that they had all looked forward to coming to Durban to hold their meeting. One of the objects was to further Municipal enterprise and to increase the efficiency of the Municipal undertakings. In handing over the Chair to Mr. Roberts, he thought he would be voicing the sentiments of all the members of the Association when he said that the status and the dignity of the Association was in safe hands with Mr. Roberts, and in honouring Mr. Roberts, by electing him to the Presidential Chair, they were honouring one of the most progressive and successful electrical engineers in the country.

Mr. Roberts then assumed the Chair.

Venue of Next Meeting.

Moved by Mr. Swingler (Capetown), seconded by Mr. Poole (Durban): "That the next Annual Meeting of the Association be held at Port Elizabeth."

Adopted.

Mr. Sankey (Port Elizabeth) assured the delegates that Port Elizabeth would extend to them a very hearty welcome, and Councillor Smith Hudson endorsed the remarks of Mr. Sankey.

Election of Vice-President.

Resolved—

"That Mr. B. Sankey (Port Elizabeth) be elected Vice-President of the Association for the ensuing year."

Election of Secretary.

Moved by Mr. Bellad-Ellis (Queenstown), seconded by Mr. Munro (Pietermaritzburg): "That Mr. E. Poole (Durban) be elected as Secretary of the Association for the ensuing year."

Adopted.

Election of Treasurer.

The Chairman said a suggestion had been made that the offices of Secretary and Treasurer should be combined.

Moved by Mr. Munro (Pietermaritzburg), seconded by Mr. Stewart (Bloemfontein): "That the offices of Secretary and Treasurer be amalgamated, and that Mr. Poole be elected to these offices."

Adopted.

Election of Council.

The President said it occurred to him that they were rather at a disadvantage that morning in having to elect their Council, as it was the first occasion of their meeting together. The suggestion had been made of having one representative from each Province, and if that were adopted it would be necessary for the representatives of each Province to confer and nominate someone.

Moved by Mr. Jagger (Ladysmith), seconded by Councillor Lawrence (Kroonstad): "That further consideration of the election of Council be deferred until a later stage in the proceedings."

Adopted.

Alteration to Rules and Constitution.

Moved by Mr. Sankey (Port Elizabeth), seconded by Mr. Munro (Pietermaritzburg): "That a clause be added to the Rules of Constitution to the effect that a Past-President shall become ex-officio a member of the Council and remain a member for a period of two years."

Adopted.

Other Business.

The President announced the receipt of a letter of welcome from the Town Clerk of Durban, and a telegram from the Mayor of Maritzburg extending a welcome to the delegates to visit the city on Wednesday.

Noted.

The President announced that two new members had been elected: Mr. P. Finlayson (the Tramways Manager of Maritzburg) and Mr. G. A. Stewart (City Engineer of Bloemfontein).

Noted.

Date of Annual Convention.

Mr. Jagger (Ladysmith) raised the question of the date of holding next year's Convention, and pointed out the difficulties experienced by those in smaller Municipalities in getting away at the end of the month. He suggested that it be a rule that the Convention should meet in the second week in the month.

Noted and resolved—

"That in fixing the date for the next Annual Convention, the suggestion of Mr. Jagger be kept in view."

Standardisation of the General Conditions of Supply and Wiring Regulations.

Discussion on this matter was introduced by Mr. Sankey (Port Elizabeth). Mr. Sankey submitted a draft of general conditions which might be applied to the matter of electric supply, and in doing so said he had not much to say regarding the details of the rules, but he wished to draw attention to the reasons which led to their being drafted. It was not intended that those rules should be hard and fast, to be voted on as they stood, but they were put before them as a basis upon which he hoped something definite and suitable to all Municipalities, so far as possible, would be drawn up, and they would then, by mutual consent, be able to adopt them as a standard. He suggested that they should form a Sub-Committee, who should during the week take the various rules and try to draft something definite to place before them.

Colonel Dobson also submitted a draft of proposed bye-laws, regulations, etc.

Mr. Swingler (Capetown) seconded the motion to appoint a Sub-Committee, and the following were elected:—Messrs. Sankey, Dobson, Bellad-Ellis, Stewart, Munro and Jagger, together with the President ex-officio.

Mayoral Luncheon.

At the close of the morning Session of the Convention, the members and delegates were entertained to luncheon at the Royal Hotel by the Mayor of Durban. The attendance included Councillors G. A. Payne (Chairman of the Electricity and Tramways Committee), and Councillor D. S. B. Anderson (former Chairman of that Committee, but presently the Chairman of the Finance Committee of the Durban Town Council). The Deputy-Mayor (Councillor C. S. Jameson) and the Borough Engineer (Mr. John Fletcher) were also present.

The toast-list comprised "The King," "His Excellency the Governor-General," and "Our Guests," all of which were submitted by the Mayor.

The toast of "Our Guests" was suitably replied to by Mr. Sankey (Port Elizabeth), who expressed appreciation of the hospitality extended to the members and delegates.

Visit to Messrs. Lever Bros.' Soap Works.

In the afternoon, through the courtesy of Messrs. Lever Bros., those attending the Convention were enabled to visit the Soap Works of Messrs. Lever Bros. at Congella, Durban. The manufacture of this commodity was seen in its various stages and proved most instructive.

TUESDAY'S PROCEEDINGS.

MEMBERS PRESENT: The President (Mr. John Roberts), W. Bellad-Ellis, G. H. Swingler, E. Poole, M. McDonough, G. A. Stewart, R. A. Stoker, W. H. Blatchford, T. Jagger, T. Millar, Colonel J. H. Dobson, T. Wolley-Dod, P. J. Gold, H. Brittle, A. S. Munro and B. Sankey.

DELEGATES PRESENT: Councillors G. A. Payne, E. Hopper, J. Crawford, S. Carter, E. W. Gilbert, C. J. Bischoff, Smith Hudson and J. M. Lawrence.

VISITORS PRESENT: Mr. J. W. Kirkland (Johannesburg) and Mr. C. J. Everatt (Johannesburg).

The Convention resumed its deliberations at 10 a.m., when the following recommendations of the Council, who had held a meeting at 9.30 a.m., were submitted for approval:—

(a) That an honorarium of £5 5s. be given to the staff of the former Secretary, Mr. Sankey, for clerical work performed during his period of office.

(b) That the copies of the Proceedings be not sent to members until the subscriptions of such members have been paid.

(c) That the copies of the Proceedings be sold for a sum of 5s. per copy as hitherto, and that spare copies be supplied to members at the rate of 24s. per dozen for six or twelve copies.

(d) That advertisements be inserted in the inside pages of the Proceedings at the rate of £2 2s. per page, and £1 1s. per half-page.

Resolved—

That the recommendations contained in the above report of the Council be approved.

Papers for the Next Convention.

The President directed the attention of members to the necessity of sending in their papers to the Council for approval. He observed that this year the papers came in very late, and it was impossible to send then out in advance. The President also called for volunteers for papers at the next Convention.

(For papers volunteered for next year's Convention, see Friday's proceedings.)

Councillor G. A. Payne, as Chairman of the Electrical Committee of the Durban Town Council, extended a welcome to members and delegates and invited them to luncheon at the Durban Club on Friday, the 31st August.

The President thanked Councillor Payne for his hospitality, and assured him that they would be pleased to accept his kind invitation.

The President then presented his Presidential address, which having already been circulated in advance he read in abstract.

ADDRESS BY MR. JOHN ROBERTS, PRESIDENT.

I must thank the members of this Association, first of all, for the honour they have done me in electing me as their second President, and I will do all in my power to make the work of the Association a success during the ensuing year.

It is now over a year-and-a-half ago since we inaugurated this Association in Johannesburg, and it is with regret we must all feel that the great event which overshadows all our lives is still continuing, though most of us believed at that time that it would have been brought to a successful conclusion ere this. And in this connection we must place on record the satisfaction we must all feel at the very worthy part played in the sphere of military affairs by our Past-President, Lieut.-Colonel Dobson, who fifteen months ago left for German East in charge of a regiment of Pioneers of his own raising, and who after about six months' service in the field returned crowned with honours and with his present high rank. It must reflect credit on us as his colleagues that our Past-President should have demonstrated so well the usefulness of the electrical engineer in modern warfare, and we thank him accordingly, and congratulate him heartily on an achievement which he will probably rank higher during the rest of his career than anything else he has done. I have heard from other sources than himself the resource and ability he displayed in overcoming difficulties inseparable from the conducting of such a campaign as the one now going on in German East Africa. I have been told of the ingenuity he employed in building bridges and so on, and I hope that during the week while we are together here he will find an opportunity of giving us at first hand some account of the interesting experiences he went through.

It must be satisfactory to us to know that the electrical engineer is playing such a leading part in this war, or, I should say, doing so much to help to bring the war to a successful conclusion. We must all feel that a more worthy part to play in the world's affairs is to promote comfort and civilisation rather than to engage in destruction—war being nothing else than destruction of human life and property.

And though Electricity is for the present the handmaid of Mars, we feel confident that when his sword is sheathed electricity will go a long way during the long spell of peace which we hope lies before humanity to promote bonds of friendliness between the nations by spreading knowledge, improving transport and communication, that war will one day cease on the earth.

But even in war-time the work of the world must go on, for the greater part of that work is the rendering possible of hostilities on their present huge scale. The fighter must be fed, clothed and supplied with ammunition and all the engines of war, besides being attended to when he is sick and wounded. He must be carried about the world, and his food and other requirements carried half-way round the globe and a good deal of it half-way back again. It is the engineer, and the electrical engineer is daily giving him more and more assistance, upon whom the result solely depends.

It is when the war is over that the engineer, and particularly the electrical engineer, will be looked to to perform the many and much-needed tasks of reconstruction to make good the fearful devastation which the war has brought about. All the overrun territories will require new railways, numberless bridges,—even towns which have, in some cases, been wiped out of existence, must be rebuilt. The ship-building industry will for years be kept busy replacing the thousands of vessels now lying at the bottom of the sea. And it is not only the direct damage caused by hostilities which must be put right. The usual work of the world has been largely suspended. Think of the thousands of miles of railways which have been gradually getting into worse and worse condition owing to the impossibility of making proper repairs, of tramways which have had branch lines taken up to replace worn-out rails on main tracks. Think of house property which has gone into bad repair for want of men to paint and mend. And think of the new schemes of development, particularly in the Colonies, which are completely arrested until the war is over. In our own country the Rand Water Board has postponed a gigantic scheme to carry water from the Vaal to the Rand. The Johannesburg Municipal Electrical Scheme has two large turbines to instal which cannot be delivered. The Capetown Municipality has a large water as well as sewerage scheme in abeyance. Pietermaritzburg has hung up large extensions to its electric undertaking. In Durban I know of large projects for establishment of industries, such as cement and soap-making, which were postponed when war broke out.

And this leads me to speak of development of the local resources of this country, to which attention is already being largely directed. A committee of technical experts has been appointed to study the possibilities of new industries in South Africa, and it must be a source of satisfaction to us to know that one of our own profession, Mr. Bernard Price, the Chief Engineer of the Victoria Falls Power Company, is the chairman of that committee. I am sure that great good will result from that committee's labours, for the possibilities are of course tremendous.

The work of the electrical engineer is bound to be so intimately associated with the development of South Africa that it is not out of place for me to make some reference to it in this Presidential Address which I have the honour of reading to the Associated Municipal Electrical Engineers of the country, for it is largely of course in your hands that the electrical future of this country lies, and it is necessary for everyone of us to realise this. It is more important for us to realise it in this country where the population is so scattered and towns and villages are so far apart than it is in such thickly populated countries as England. For the day is not far distant in England when the generation of power will be done in great mammoth stations and the small towns will give up their small inefficient stations. But in South Africa it will be many years before the towns will be linked together into one common network, though it is bound to come one day, and the consequence is that for some time yet every town must be responsible for the supply of current within and around its borders till the branches grow outwards sufficiently far to meet.

Knowing, as we all do, the stimulation to industry which a good local supply of electricity brings about, one or two things follow:—

(1) That municipal electrical engineers must wake up to their responsibilities to local industries.

(2) To so design new schemes, and, if necessary, modify old ones, that they place themselves in a position to meet any reasonable demand for power which may be suggested in their territory.

(3) By such a policy they may be able to promote local industries which otherwise may be driven to larger centres of population where supply of current can be secured.

Many illustrations of the third point in the above may be quoted. Take wattle-bark, which up to the breaking out of war was exported as it was stripped from the tree. It would seem to be much more sensible and advantageous to export the extract instead of the bark, thus saving considerably in freight and yielding the tanning product locally, which would undoubtedly tend to the quicker establishment of an industry to turn our own hides into leather. Such an extraction plant will soon be in operation near Durban. But why not up-country where the bark is grown? It will rest greatly with municipal electrical engineers to induce manufacturers to manufacture as near the seat of agriculture as possible instead of railing the raw material to the large towns to be manufactured there. Other cases could be quoted. The making of cheese, the freezing of beef, should all be done as near as possible to where the cattle are reared.

It is not out of place, therefore, to call your attention to the necessity of a careful study of the possibilities of the establishment of local industries in your respective territories. In many cases you will have to study the manufacturing conditions closely in order to put yourselves in a position to advise as to the best way to apply electricity to it. For it is not sufficient in many cases to be content with a general recommendation to use an electric motor, for usually the owner is not acquainted with the electric drive, and one has got to know sufficient of his work to demonstrate not only how to solve the power problem, but to show in what way electricity will be superior to steam. In Durban we have found it necessary to get some acquaintance with a number of widely different industries, for at first a good deal of missionary work had to be done and the educational work has now borne good fruit, and we find little difficulty in securing power customers nowadays. But we had to learn the peculiar conditions of such diverse businesses as wool-pressing, bark disintegrating, sugar refining, brick-making and cold storage, and we can now not only give advice on the electric side of the proposition, but advise on many of the technical points in regard to some of these concerns if it is asked for.

This brings me, therefore, to some mention of the South African industries which may be developed and established as a result of the committee with Mr. Bernard Price at its head. Their labours will probably lie outside the consideration of agriculture and farming for many years, and these will, I hope, remain the foundation of the country's progress and prosperity; as we municipal electrical engineers stand as the exponents of electrical enterprise, we must keep before the farmer the advantages of electricity, especially in irrigation work, and should make ourselves acquainted with the immense work done in this direction in the arid parts of the Western United States, where vast tracts of arid deserts have been made to blossom by water pumped by electric power. And everyone in his territory must be a missionary spreading the doctrine of "electricity for the farmer." One's efforts should not be confined to those who may be within reach of our mains; one may recommend a farmer to put in his own little plant, and then, when his example has been followed by his neighbours a demand for current will be created sufficient to warrant taking lines out to shut up the isolated plants.

Of course I am aware that though the farmer is more susceptible to the reception of new ideas than he was, it will be a tough job at first, but easy when the foundation is laid, for when one is making a success he gets plenty of imitators. I was recently on a farm in the Transvaal where dairying was the principal objective, and where things were laid out on good lines, to send a large supply of clean milk to Johannesburg every day. An engine and boiler were running doing various jobs, but I could see how advantageous a small electric plant would have been for milking, grain crushing, ensilage cutting, pumping, elevating, etc., but I could see also the big job it would have been to get the farmer to see it too, and he was quite a progressive man.

As a result of the great progress the farmer is making in cattle raising, the meat industry is looming up, and there can be no doubt that our limitless veldt will produce meat in quantities comparable with what the Argentine is doing, and the higher standard of living in European countries will call for increasing quantities of meat for food. A large export of meat will bring with it the possibilities of many new industries, such as tanning, manure-making, cold storage plants, and every live electrical engineer must get into a position to cater for demands for power which may arise in connection with these, and, if necessary, push electricity as the motive power instead of steam.

As cattle raising progresses it is probable that the export of maize will diminish, for it will probably be found that the use of this local product for feeding will be more profitable than selling it for export, and this strikes one as being sounder and consequently the number of mills for crushing and milling maize is likely to increase and a flour mill should be an excellent customer for power. Frequently they run for 24 hours per day, and preferential terms could be offered.

There is not much hope, I am afraid, except in the case of the largest plants, to sell current for electrolytic or electro-chemical processes, or for electric furnaces. But these are industries which should be kept in mind, for their development has altered the condition of many old-established undertakings. It is stated, for instance, that an electric steel furnace is already at work on the Rand, as well as a plant for making calcium carbide in an electric furnace. The cost of power in small plants is usually much too high to attract such industries as these, and the engineer of the small station has got a difficult problem to tackle in bringing down his cost to a figure comparable with what can be obtained in the large undertakings. His difficulty is the small output, the cost of attendance and capital charges, the standing charges in fact amounting to a large figure per unit owing to the small output. And this brings me to the next subject on which I shall touch in this brief address.

It is the importance to the small station of so designing the plant as to be able to deal with demands for power at moderate charges. The total cost in the small undertaking is, as I have said, high in most cases because the standing charges are excessive, due to the small production, but this cost would automatically fall if the output could be brought up, such as, for instance, by the addition of a good power load, so that need not be a cause for concern. But I am afraid that in some cases the variable costs, principally fuel, are also high, and this high figure per unit will not go down much with the addition of load, and in such a case as this, then, it is hopeless to try and cultivate a large output profitably. The aim must be to lower fuel and repairs cost to the minimum, so that by increasing the output the total cost will not increase much, due of course to the standing charges remaining fixed. To secure such a state of things it is useless, for instance, to run a plant with non-condensing steam engines even where coal is cheap. Many engineers, I think, forget that by installing condensers you increase the capacity of your plant by at least 20 per cent. (the boilers and engines, at any rate, if not the generators); at a moderate cost and on equal loads in addition to saving cost of fuel you save handling of coal and ashes, besides maintenance of boilers by the lower evaporation required. But even with condensing steam engines operating costs in a small plant are heavy, and something better than this must, I think, be aimed at. I do not think that the Diesel engine is the right solution. The fact that one has to depend on fuel from overseas is, I think, sufficient to condemn it. I must confess I am surprised that the gas engine has received such comparatively small support from the municipal electrical engineer of the small town, though in private enterprise their success has been well demonstrated. I believe that Mr. McDonough, of Bethlehem, has had uniform success with his gas engines, and his fuel cost must be a mere fraction of what it would have been if his prime movers had been non-condensing steam engines. I should be very glad if some of those present from the smaller towns will throw some further light on this important question.

Another point on which I will only briefly touch is that on which I am down to contribute a paper to this Conference, that of Standardisation of systems and supplies. Standardisation, as we all know, is in the air all over the world, and the need of more uniformity in all branches of engineering than now exists is really very pressing. We all know the handicaps under which we suffer now through the want of understanding between us as to such matters as the best pressures and periodicities to employ, and the complete lack of co-ordination in the plant we buy. I sincerely trust that everyone here is ready to go to considerable trouble to arrive at some understanding on, at any rate, a few of the more important essentials in regard to systems and plant which concern us all. I am certain we shall place the electrical industry under a debt of gratitude to us if we can do something to reduce the great and unnecessary variety of plant and apparatus which now has to be stocked, a condition which is bound to result in much higher prices and greater difficulties in procuring our requirements than need be the case.

I should like to say that we now happen to have a great opportunity before us at the present time, as I will explain. A few months ago the Natal Engineering Society made certain representations to the South African Institute of Electrical Engineers in regard to general engineering standardisation. It then appeared that a Standardisation Committee had been in existence in Johannesburg for many years past, but for some time its activities had been suspended and nothing practical had been accomplished. The representations we made roused considerable interest, however, and the outcome was that a new committee was got together embracing representatives from the following bodies:—

South African Institute of Electrical Engineers.
South African Institute of Engineers.
Association of Municipal Electrical Engineers (S.A.).
Engineering Section Natal Society for the Advancement of Science and Art.
British Electrical and Allied Manufacturers' Association.
Institute of Electrical Engineers, England.
Government Departments, Union of South Africa.

I had the honour of attending the first meeting held in Johannesburg in May last, and the various committees were selected, Mr. F. W. Mills, the Chief Railway Electrical Engineer, being appointed chairman of the main committee. At that meeting, which I attended as one of your representatives, I stated that our Association was expected to meet shortly in Durban, and that we should probably be discussing the matter of Standardisation as it affected our particular branch of electrical work, and I was therefore asked to request the Association to kindly send any representations it cared to make for consideration of the Standards Committee. I trust that at our Convention this year we shall have time to give the matter of Standardisation, both of systems and supplies, considerable attention, and go some way to put an end to the present chaotic state of affairs electrical in this country.

This important question is brought somewhat into prominence at the present time owing to a most interesting development in the Railway policy of South Africa which is foreshadowed by the General Manager, Sir Wm. Hoy, in his last annual report. That progressive administrator is thoroughly alive to the benefits which the large railway system he controls would derive by the introduction of electricity instead of steam as the motive power not only for suburban but for main line trains. My opinion on the subject may not be worth much, but I am convinced that on many of the sections of the railways on which traffic is now dense, where, in fact, the lines are carrying up to their utmost capacity, notably on the Natal main line, a substantial improvement in both carrying capacity and reduction in working expenses would be achieved by the electric locomotive. The heaviest train now hauled behind an engine on the Natal gradients is 650 tons. On the Chicago-St. Louis and St. Paul Railway, in the United States of America, there are now 400 miles of line in regular daily operation by electricity over more difficult country than we have to contend with, and the electric locomotives on this line actually haul a gross load behind them of 3,000 tons, the grades being as high as one in fifty (2 per cent.).

The Natal Engineers' Society, at their meeting in Durban in July last, had the advantage of hearing a lecture on this new railway by Mr. J. W. Kirkland, of Johannesburg, and the information he gave was a revelation to all those present. The lecture was particularly interesting, illustrated as it was by beautiful bioscope films and slides. It is not unlikely that Mr. Kirkland may be prevailed on to deliver his lecture again in Durban during our Convention here, and, if so, the members attending have an unusual privilege in store for them. I particularly mention this matter of Railway Electrification before our Society because it is a matter which closely affects us in our position as almost the sole suppliers of current throughout the Union leaving out, of course, the Rand Mines and the Victoria Falls Power Company. We are closely interested in the subject because the South African Railways have (under the advice of their Chief Electrical Engineer, Mr. F. W. Mills) given up generating current for themselves, and now all the principal towns of the country take their supplies of electricity from the local municipal plants. This is a progressive and broad-minded policy which reflects great credit on the management and its advisers. It follows, therefore, that when the time comes, as I believe it will at no distant date, when the Administration must consider supplies of electricity on a large scale for railway power, the Municipalities will be given an opportunity of submitting propositions for such a supply. Within the next few years, therefore, some understanding between the Municipalities should be come to as to the terms which should be offered, class of current supplied, etc. It does not necessarily follow that the same terms would be given by each. The difference in local cost of coal and other local conditions would preclude such uniformity, but some common basis depending on local factors might be determined, embracing such questions as length of period of contract, liability for failure, etc. It would, I am sure, be a mistake for one town to make an important contract without reference to others who might some day have to offer terms, especially when it is remembered that the terms of the first contract are likely to largely influence contracts made subsequently. I think everyone will agree that such a subject as this proves the necessity of such an Association as ours and the great desirability of occasionally meeting together and discussing questions which we all may at any time have to solve. It also proves the extreme necessity of every member of our Association being present at our Annual Convention and the need of everyone taking the view that the work of our Congress is at least as important, if not more important, than any other work our different local duties entail. We all have our diverse problems to tackle, but it is essential in the interests of our important industry that nothing we may do will adversely affect other undertakings by establishing undesirable precedents or increasing the already very great variety of plant which manufacturers and merchants must supply to us.

This Address would be incomplete without some reference to the arduous and trying conditions under which many of us are carrying out our work in these trying war times. I am sure we are doing it uncomplainingly as being a very small contribution to the sacrifices which the Empire is requiring from everyone in order to bring the war to a successful conclusion.

The difficulties we labour under are, of course, in getting proper skilled labour and materials. The ranks of engineering artisans have been depleted more than those of most businesses owing to the great demands for engineers made by the war, and the position is more acute in peaceful employments because we have been called on to make locally many things we used to import, owing to shipping difficulties and prohibitions on export. There has, therefore, been a great deal of scope for ingenuity in devising artifices and devices out of materials available to do work for which usual requirements are lacking. It may be of interest to give a brief account of some of those devices which we have adopted in Durban, and so far, I am glad to say, we have been able to go on taking on customers much as before the war, though our position in regard to amount of plant three years ago was probably better than most other peoples.

POLES.—Owing to local supplies of cement, the cost of concrete has not advanced much, and we have adopted in certain instances concrete poles in place of steel or cast-iron poles we used to employ. These, we find, have advantages as regards durability. Steel poles being practically unprocurable, we have also adopted wooden poles (Jarrah), but the price of these is also advancing at a very formidable rate. I give below some figures, which will be of interest, poles 30 feet long:—

Type of pole.	Pre-war Price.	Present Price.
Siemens type pole weight 500lb.	£4 4 0	Unprocurable.
Wood pole 6in. x 4in., 25ft. long	1 14 0	£3 7 6
Concrete pole	5 0 0	——

The wood pole has a special protecting case portion to prevent destruction by white ants.

DISTRIBUTION LINES AND CABLES.—This has been, of course, one of the most difficult class of supplies. Even if procurable, the cost is almost prohibitive except in the case of small sizes of wires. We have consequently gone over our distribution plans very carefully to discover where copper is in excess, and have taken down one long overhead high tension line and made up from it three shorter lines to feed the central district, and are recovering a good deal of underground cable, which will come in for low tension distribution. We are also taking down ground wires which we regularly employed above all high and low tension overhead conductors, as we are doubtful if these are of the value we used to think they were. This will yield us considerable quantities of bare copper wire for small extensions of our lines. Fortunately the new demands from large consumers of power are not coming in fast, as such consumers cannot obtain machinery for new enterprises.

METERS.—These at the present time are very difficult to obtain, and we are putting back into service a number of old types of meters we took down as being obsolete, but which we kept in reserve for unforeseen emergencies, and they are coming in very useful now. We are considering recommending a minimum charge to private consumers so that we can recover instruments from properties where the consumption is very low, say under six units a month.

CONSTRUCTIONAL MATERIALS.—We have had to do quite a lot of constructional work both in the Power Station and outside, and owing to the high price of steel sections of all kinds we have very largely used old steel tram rails for all kinds of work—generally in combination with concrete. We have built up switchboards with these rails as a framework, using asbestos "Eternit" or similar sheeting as coverings and as partitions. Latterly we have been bringing in old boiler tubes as uprights for switchboard panels. Though the general appearance is not so good it must not be thought that the results so far as reliability goes are any worse; in fact, we have aimed at doing better work than usual now, as it is important to reduce maintenance costs on account of the shortage of skilled attendance.

REINFORCED CONCRETE.—We have been carefully studying the possibilities of the substitution of this material for steel and iron wherever possible, and I have already referred to it under the heading of poles. We are now considering it for the making of tanks, etc., and have planned to build a new condensing water pipe line of reinforced concrete pipes 21in. in diameter. The local cement, though slow in setting qualities, gives quite satisfactory reinforced concrete results. Speaking generally, it is wonderful what can be done when one is thrown on one's own resources. Scrap heaps should be carefully sorted over and the materials classified, and much old stuff which it would not have been profitable to use before is now worth money. One should hesitate before anything is sold as scrap; our scrap heap which before was almost valueless is now, I reckon, worth hundreds of pounds.

BUS-BAR COPPER.—We are using old short lengths of trolley wire, bound together, as switchboard bus-bar, and in some cases are putting this up in place of heavy bars, which can thus be taken down and used elsewhere. It is a great satisfaction to know that porcelain insulators are now made in the Transvaal.

GLASSWARE.—Enclosing globes for street lighting are very scarce, but we are discarding these in some cases, and do not find much disadvantage. It would be interesting to have the experience of others on this question.

I conclude this brief Address by expressing the hope that you will all have a pleasant and profitable stay in Durban. It is very largely, if not almost entirely due to Mr. Sankey, of Port Elizabeth, that there is every promise that this Convention will be a great success. He took over the secretarial duties since our last Convention, and has been unremitting in his efforts to promote the interests of the Association, and we are all under a deep debt of gratitude to him for the labours he has so willingly undertaken, especially considering that he has been heavily engaged in reorganising, improving and extending his own plant in Port Elizabeth, a task in which, I am sure, we wish him every success.

I thank you once more for the honour you have done me in electing me as your President for the ensuing period, and undertake to do my best to make my period of office successful.

TARIFFS.

At the last Convention, held in Johannesburg, Mr. John Roberts (Durban) gave a paper upon the question of Tariffs. Owing to lack of opportunity, no discussion took place on that occasion, further consideration being adjourned until the next meeting of the Convention. In terms of that decision, Mr. Roberts presented further data connected with the subject, but before doing so requested to be allowed to vacate the Chair in view of the controversial nature of the business.

The President then vacated the Chair, Mr. Sankey (vice-president) taking the Chair pro tem.

Mr. Roberts then proceeded to read the following addendum to his original paper:—

In the paper I had the honour of presenting on the subject of Tariffs for Electric Current, I drew attention to the possibility of selling at low prices when once the standing charges of an undertaking had been defrayed.

In opening the discussion which is set down in our programme to take place at the present Convention, I wish to deal briefly with this aspect of the question on the following lines:—

1. A town cannot receive the full benefits of electricity unless prices charged are low.

2. It pays to offer low prices, even though a loss may result at first, because of the increase in consumption which is sure to take place.

3. The manner of securing that the ultimate result will be satisfactory is to recognise the difference between standing and variable charges, and to regulate tariffs accordingly.

In regard to No. 1, I will not labour this point, but to show how much electricity can be absorbed in a community where current is sold cheaply, I refer to a diagram I included in my first paper, in which there was shown the growth of cheap rate current since low domestic rates have been inaugurated, and I can now add two more years' figures to the diagram. The following figures are plotted in this diagram, and show the progress being made in the sale of cheap rate units for purposes other than industrial motive power—principally for heating and cooking:—

Units sold at d.	Year ending 31st July, 1915.	1916.	1917.
5½	1,958,000	2,170,000	2,475,000
2	150,000	189,000	233,000
1	172,000	205,000	245,000
⅝	689,000	930,000	1,252,000

The following is the percentage growth of the various priced supplies in the last two years:—

5½d.	26%
2d.	55%
1d.	43%
⅝d.	80%
Total supply	40%

It will be seen that in 1915 the cheap rate (⅝d.) units amounted to 23% of the whole, while in the year ending July, 1917, they represent 30% of the whole amount sold for lighting and heating. Needless to say, saturation point is not yet even in sight, in fact it might be said that the solution of current in the population is very weak so far. When the consumption reaches 6,000 units per domestic consumer per annum we shall then be somewhat near what is to be aimed at, or say 6,000 x 7,000 equals 42,000,000 units a year for the Durban undertaking, instead of 4,205,000, the present consumption of the lighting and heating users. So long, of course, as current is sold only at ordinary lighting rates it is clear that such a demand as is suggested above is impossible, and the first essential is to bring rates down.

The next point is that so long as the output is limited, then costs of production are bound to be high, and it is no argument to say one cannot lower rates because low prices would not pay. They will pay when the demand has been encouraged, but business may have to be taken at a loss till the demand springs up.

I deal with the question of costs under point No. 3, and I wish to show some diagrams which I hope will illustrate some of the principles of rational tariff making, making apologies in advance if I traverse too familiar grounds.

In the first place, one can never keep too prominently before him the great underlying facts of electricity production:—

(1) That costs fall into two classes: standing charges and variable charges.

(2) That the standing charges are by far the higher of the two.

(3) That a system of charging which does not take these facts into account can never be successful.

I would like to remark here that the above is, of course, a presentation of the subject in its very simplest form and needs elaboration before one can apply the principles in practice, but the fundamental fact as above holds good in nearly all cases except perhaps in restricted hour service.

I show a chart (Fig. 1), illustrating from the costs of the last completed year's working of the Durban undertaking:—

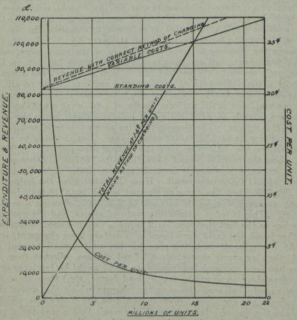

Fig. 1.

CHART TO ILLUSTRATE METHODS OF CHARGING.

(1) Standing charges (£82,000 per annum).

(2) Variable charges (£29,000 per annum).

(3) Cost per unit from 1,000,000 units up to the full output of 22,000,000 units, worked out from above figures.

The line marked Variable Charges being superimposed on the Standing Charges should be more accurately marked total charges, for the ordinates measured from the base line are the total of standing plus variable. This line of total costs, it will be noticed, never falls below £82,000, the amount of the standing charges, even when the output is nil, or, in other words, the interest charges, liability for wages, repairs to distribution plant, etc., go on whether the plant is working or not. This implies that as soon as a consumer becomes connected he immediately involves a comparatively large expense to the supplier if he only consumes one unit per month. This one unit, in fact, which on a flat rate method of charging he would pay 6d. for, might easily cost 5s., whereas if he used 100 units they might not altogether cost more than, say, 7s. 6d. Such a statement is sufficient to condemn the flat rate method of charging for current. Look at Chart No. 3. In this chart are shown the standing and variable charges of the same magnitude as the Durban plant, and we imagine that the output has got up to 15 million units shown by the vertical line. Now suppose it was attempted to devise a plain flat rate of so much per unit applicable to all consumers, large and small. We find the total costs at that output are 1.6d. per unit, and if the uniform charge of 1.6d. were made the expenditure and revenue at £102,000 would balance exactly when the output reached this figure. The sloping red line shows the total revenue and it intercepts costs at 15,000,000 units a year. But if owing to adverse circumstances the following year the output dropped to 13,000,000 units, then the revenue would have fallen to £87,000, whereas the working expenses would only have dropped to £98,000, and a loss on the year of £11,000 would result. If on the other hand the output rose to 17,000,000, then the revenue derived would be £114,000, but the working expenses would only increase to £103,000, showing a profit of £11,000. This is not a satisfactory state of affairs, and the reason of course lies in the fact that the tariff is not a rational one. Suppose, on the other hand, the tariff were based on a certain fixed charge of, let us say, £5 per kilowatt installed plus ½d. per unit for all current consumed, then assuming that the total fixed charges collected from consumers had been so regulated (the figure of £5 might be too large or too small, depending on diversity factor, load factor, etc.) that these fixed charges exactly balanced the standing charges which the undertaking had to find, then the line of revenue would be the dotted line which is just above the line of total costs, with the result that a reasonable profit is assured to the undertaking whatever might be the output, and what is just as important, power and heating loads would be encouraged by the low unit charge.

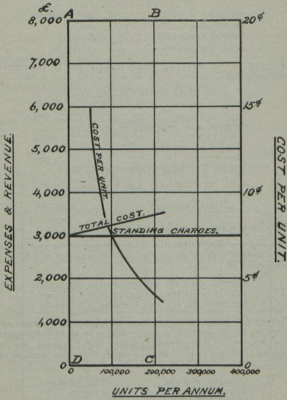

Fig. 2.

It may be argued that the above data and diagrams, being based on the station of a large town, are not applicable to the small municipality, so I give some corresponding figures which show the favourable effect of increased output on costs in a small electric power plant.

We imagine first of all a plant doing only lighting work with a load factor of 20% (that is, owing to no day load the plant only turns out one-fifth of what it is capable if run at steady load 24 hours a day):—

Capacity of plant	100 kilowatts.
Load factor	25%
Capital expenditure	£15,000
Units per annum	219,000

The expenses of operating such a plant would be (assuming steam engine operation):—

STANDING CHARGES.

Wages, etc. (say)	£1,000
Administration	500
Interest and depreciation, 10% on £15,000	1,500
	3,000

RUNNING COST.

Coal, oil, repairs, at 1½d. per unit ...	455
Total expenses	£3,455

The cost per unit on the above basis would be 3.8d.

The diagram illustrating the relationship between cost and output of such a station is as shown in Fig. 2, from which it will be seen that with an output of

50,000 units the cost per unit is 15 pence.
100,000 units the cost per unit is 7.7 pence.
219,000 units the cost per unit is 3.8 pence.

Now we will assume that this same station is able to secure an additional outlet for its current so as to employ it at full demand for 24 hours a day, or, in other words, its load factor reaches the highest possible, viz., 100 per cent. But to supply this extra demand, £5,000 has to be spent in mains. The data would then be as follows:—

Capacity of plant	100 kilowatts.
Power factor	100%
Units per annum	876,000
Capital expenditure	£20,000

STANDING CHARGES.

Wages (as before)...	£1,000
Administration (as before)	500
Interest and depreciation, 10% on £20,000	2,000
	£3,500

RUNNING COSTS.

As before, ½d. per unit	£1,800
Total cost...	£5,300

the total cost per unit being 1.45d.

But this is not the lowest figure at which it would be possible to charge for the additional load, as indicated below:—

Extra units sold, 876,000 − 219,000 = 657,000

Extra cost entailed by supplying these units are:—

Standing charges...	£500
Running costs, 657,000 units at ½d.	1,360
Total extra cost...	£1,860

which works out at .68d. per unit.

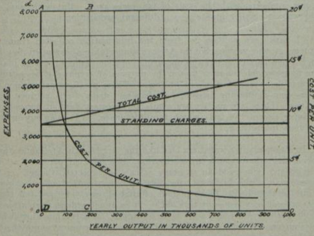

Fig. 3.

Chart No. 3 shows the working costs of a station with such an output. The left hand portion of the chart marked A B C D is practically identical with the previous chart. The portion to the right shows how the cost decreases as the output rises.

Of course no ingenuity in fixing tariffs is of any avail in making an inefficient plant successful. The first cost of the plant must be reasonable, so that the standing charges of interest, etc., are not too heavy, and, further, the plant must be economical so that the variable costs (principally fuel) are brought down to the minimum. I will not say anything about what the amount of the standing charges should be. The cost of a town installation depends on so many variable factors that it is impossible to say what a scheme capable of a given output of current ought to cost. The figure would depend on the diversity of the load, the position of the best site for the power station, and so on. But it may be of interest to say something about working costs. From the paper we are getting this week by Mr. Poole there will be found great variations in the cost of electricity production in the various towns in the country. In writing these notes I have in mind the conditions of the small plant, because that is where the greatest difficulty will be found in selling current at such prices as will enable power to be sold at low enough figures to encourage power and heating. The problem in large plants is comparatively easy. The large steam power station equipped with modern plant is cheap and simple to operate at very low figures compared with the costs of ten years ago. But with, say, 100 kilowatts or smaller plants it is a different proposition.

I have been able to get from the information collected from the returns of the various South African undertakings compiled by Mr. Poole some particulars of the operating costs of various types of plants. The figure which concerns us for the purpose of arriving at an estimate of variable charges is the cost of fuel. There are four principal plant types—non-condensing steam, condensing steam, oil engines, gas engines. There are particulars available necessary for our purpose for all types except the last, which is unfortunate, as it is in my opinion the most interesting.

In steam plants of medium size like the large South African stations, where turbines form the prime movers, 3lbs. of coal per unit at the switchboard is as good an economy as can be expected, though in the largest plants in other countries 2lbs. only is required where economy is carefully studied. Three pounds of coal at, say, 14s. per ton represents a coal cost per unit of .25d. It is thus evident that after all standing charges are defrayed by a consumer, a charge per unit (where distribution expenses per unit are light, as for instance where the demand is large and the consumer near the works) of ⅜d. begins to be quite in the region of practical politics.

But in small steam plants the case has quite a different complexion. I have gone through some of Mr. Poole's information and find as follows in regard to the four different types of plant referred to above:—

STEAM ENGINES (Non-condensing).—In two types of plants turning out from 350,000 to 500,000 units a year respectively the coal consumption is 12lbs. per unit, the average cost of the two being .66d. Allowing, say, a quarter of the fuel is used for stand-by purposes and is required for running the engines light, the actual coal required for every additional unit generated would be practically .5d.

STEAM ENGINES (Condensing).—In two typical cases where condensing engines are installed, the output being 300,000 and 750,000 units respectively, the coal consumption is 6½lbs. on the average, but as they operate in places where coal is dearer than in case No. 1, the coal per unit is even in the lowest instance as high as .6d., which would on the same basis of reckoning, stand-by fuel, etc., make the cost of coal per additional unit turned out as high as .45d.

OIL ENGINES.—I can obtain information on the cost of fuel in three oil engine stations with outputs varying from 78,000 to 150,000 units per annum. Unfortunately the actual amount of fuel, or its cost per ton, is not available, but the most important figure, the cost per unit, is given, and runs between .78d. and 1.36d., the average being exactly 1d. per unit. It is not necessary to make so high provision for stand-by and engine losses as in the case of the steam engines, and we may therefore assume that every additional unit will cost, say, .8d. per unit.

GAS ENGINES.—In the absence of information on this type, we have to make estimates (which should err on the safe side), and I base them as follows:—

Coal—12,500 B.T.U.'s per lb. 1 B.T.U. equals .000291 k.w. hours.
Producer efficiency—say 65%
Engine and generator efficiency—say 27%
Gross efficiency from coal to k.w. hours, 17.5%.
12,500 B.T.U.'s equal 3.49 k.w. hours.
17% of 3.49 equals .61 k.w. hours. Therefore 1 k.w. hour will need 1.65lbs. of coal.

We do not have to make provision for stand-by losses in the producer, etc., as we are only arriving at the running costs, and we fix these at 2lbs. of coal per unit. With coal at 10s. per ton, the cost would be .12d. per unit; with coal at £1 per ton, the cost would be ·25d. per lb.

We arrive therefore at the following for the variable charges for the different types of prime mover:—

Type.	Fuel per ton.	Price per unit.
Non-Condensing Steam	10s.	.5d.
Condensing Steam	14s.	.45d.
Oil	—	.8d.
Gas	20s.	.25d.

Bringing the figures into line by correcting them for coal at 15s. per ton in every case, the list would then be:—

Non-Condensing Steam	.75d. per unit.
Condensing Steam	.48d. per unit.
Oil	.8d. per unit.
Gas	.19d. per unit.

These figures I hope it will be understood represent the cost per unit of producing extra units in addition to already existing load in fuel alone, assuming in the case of coal that it costs 15s. per ton. There will be other variable charges, especially repairs, which will increase with the output particularly on the boiler plant, but fuel is of course the chief item of the variable expense. The figures indicate the chances of supplying current to a Cold Storage Works wanting, let us say, 100-h.p. for twelve hours a day right through the year. Such a works would be likely to operate a high-class condensing steam plant, and consequently it would be quite impossible to supply such a concern with power from a non-condensing works at figures profitable to both. Considering that such a plant requires some skilled attendance for the refrigerating machinery, whether they use steam or electricity as the motive power, even a condensing proposition would find it difficult to make a satisfactory price.

Further, it will be seen what prospects these plants have of selling electricity at ½d. per unit for cooking and heating.

The object of this opening of the discussion on Tariffs for Current should be considered as tentative only, and likely perhaps to challenge further criticism of my original paper.

The Discussion.

Mr. BELLAD-ELLIS (Queenstown) said that on the subject of Tariffs the smaller municipalities had many difficulties to contend with and could not be placed on all fours with the larger towns. The greatest stumbling block was trying to prove to the layman that a point was reached when the scheme, having reached the state of clearing all expenses, could afford to supply units at cost, or that which appeared to the layman as cost. He further proceeded to give a comparison between the cost of units supplied with D.C. plant with battery, as compared with A.C. plant and three shifts of men. He emphasised the point of engineers having to be also business men, and pointed out the necessity of cheap units for cooking in order to compete with wood, coal, etc., and to eventually displace it in order to meet the needs of the housewife.

Mr. McDONOUGH (Bethlehem) said there was one matter he wished to touch upon, the absence of any particulars in regard to the gas engine plant. He had had a request from Mr. Poole to furnish him with details regarding the plant at Bethlehem, which he would do later. He did not think there was another gas engine of its type in the country, and he believed that fuel costs on this type of plant were even lower than those mentioned by Mr. Roberts in his paper.

Mr. BLATCHFORD (Greytown) drew particular attention to the cost of the small station, where the fuel costs amounted to about 12 per cent. of the total production, as compared with 50 per cent. in a large station, and he pointed out that consequently, in a small station, there were other items of equal and perhaps greater importance. He called attention to the difficulties in a small town with sparsely inhabited areas of catering for demands for supply, and stated that the advent of the metallic filament lamp had compelled them to look in other directions, such as heating, cooking, etc., to maintain and develop their production.

Mr. JAGGER (Ladysmith) said he was sure that had members of Town Councils heard Mr. Roberts they would have received an education in the cost of current and the reason why they as engineers were always endeavouring to bring in low charges for power. In connection with Mr. Roberts' paper on Tariffs which was read at the previous Convention, he noticed that the charges to the Railway at Durban were three-farthings per unit for high tension three-phase plus 10% for D/C, whereas the charge to the trams, which were a municipal concern, was 1d. per unit, metered at the switchboard. He could not follow why the Tramways should have to pay a higher rate than an outside firm. The price of heating and cooking was ⅞d. to householders and ⅞d. per unit to hotels, boarding-houses, etc. Why did they pay one-eighth more than private consumers? Another little item was the flat rate of 5½d., and the minimum charge to business houses, but no minimum charge to private householders.

Mr. STOKER (Kroonstad) said he happened to be one of those unfortunates who had to operate what was one of the most inefficient types of station, for the reason that they had a non-condensing steam plant. Mr. Roberts had given certain figures relative to the operation of a station of that kind, but he thought he had placed his coal costs too low. In Kroonstad they turned out 500,000 units a year, and their coal costs were .8d. per unit. Very often a lot of those who were small fry were rather shy of introducing a tariff for cheap current, for they were afraid of what would happen to them. Last year he found himself called upon to supply a largely increased output of current at their cheapest rate, so that his experience would be rather interesting, and he found, as a result, that the large increase in current which they had to sell at their cheapest rate—2½d. per unit—had the effect of increasing the current on the year's working, and on the cheap rate, by 11% of their total output, and the actual decrease of cost per unit was 10%, so that with that experience he did not think that any of them need be frightened to introduce a cheap tariff if they could look forward to any fairly large consumption.

Colonel DOBSON (Johannesburg) said the question of Tariffs is the most important subject connected with any trading concern, as no matter how efficiently the other sections of the business may be run, the policy of the tariffs spells success or ruin to the undertaking. Mr. Roberts has brought forward in a detailed manner the question of the tariffs in vogue at Durban, as well as certain general principles which apply to most municipal electrical undertakings supplying electricity for lighting and other purposes, whether on a large or small scale.

A power station working on a peak load during the maximum hours of lighting and thus working on a low load factor, there are probably at least 18 hours of the day during which time it will pay to sell electricity at a cost equal to the works cost or even slightly less, always provided there are no additional distribution costs involved in such supplies. Where there are appreciable additional distribution costs in giving supplies during the 18 hours of low load on the plant at the power station, such distribution costs are a fair charge on these supplies.

The question of differentiation of charges at the times of peak loads and the number of units of demand, restricted and unrestricted times, and the maximum demand, are variable factors which provide reasons for the great variations in the prices per unit sold.

Before dealing with the Durban tariffs seriatim, I desire to state that in connection with the Johannesburg Municipal undertaking no less than 89 suburbs are given supply over an area of approximately 90 square miles. It will be understood how difficult it has been to find capital moneys for this development not only in connection with the Power Station plant, but more particularly with regard to the distribution plant. There are still twelve suburbs without electrical supply, and it is an avowed policy of the Council of Johannesburg to supply electricity for lighting purposes irrespective of payability. For this reason, although electricity is sold at prices varying from 6d. to .625d. per unit, according to conditions of supply and demand, the Department has not yet embarked upon a serious campaign of attempting to entirely eliminate the use of coal by the use of electricity for the total domestic requirements of heating and cooking in the ordinary household. The time is not far distant when capital moneys will have been provided to give supply to all these suburbs, and then the question of total domestic supply will become an important section of the work of the Department. For this reason alone the experience of Mr. Roberts will be of enormous benefit to me in advising my Council. Such being the case, I desire to take full advantage of Mr. Roberts' paper by asking questions on the numerous points of controversy in connection with tariffs. I am sure his replies will be an amplification of his excellent and instructive information to members of this Association, who, like myself, would like to know the financial and economic results obtained by the policy of selling electricity for domestic purposes at very low rates without restriction regarding the times of the day when the same may be drawn from the Council's mains. I wish to make it clear that in any questions that I may put to the author it should not be implied that I am condemning an existing policy, because every municipal electrical engineer knows his own local conditions best. I desire to obtain information from the points of view of the question of low tariffs.

As the fundamental principles of finance must enter into the question of tariffs, I would like to ask Mr. Roberts to give some information as to the policy of his Corporation in regard to its loans, sinking funds and renewals or depreciation funds. In order to facilitate his reply, I submit the following figures, taken from the Treasurer's statement of accounts for 1915:—

	Total Capital.	Loans.	Capital from Revenue, including Reserve Fund in connection with the failure of the Gas Engines.	Redemption.	Renewal.
Johannesburg	£1,060,162 ...	£959,295 ...	£100,867 ...	£244,326 ...	£125,853
			65,000		
			£165,867		
Durban ...	£543,863 ...	£415,000 ...	£128,863 ...	£30,653 ...	£10,035

Does the Council of Durban so arrange its loans that the amount set aside per year for the sinking fund accumulates in amount to the original loan when it is due for payment? These facts affect the question of capital charges, and in connection with this point it is observed from the Treasurer's statement that a loan of £84,000 4% bonds is due in 1918. The amount in the sinking fund as and at July, 1915, was £30,653, and this was added to by £6,710, and thus increased to £37,363 in 1916. As £84,000 is due in 1918, and as £30,653 accumulated in 1915 seems low on a present loan debt of £415,000, I would be glad if he would dilate on this question and the method adopted for paying off the loans. I would also like Mr. Roberts to give some information on the same lines regarding the Renewals Fund, which in 1915 stood at the relatively low figure of £10,085 compared with the much larger figure comparatively in the case of Johannesburg, although it may be said that the plant in Johannesburg is more recent than that of Durban.

Another item which touches upon the same subject is the amounts which go to the benefit of the ratepayer in relief of rates. At Durban an amount of £17,336 on a total capital of £543,863 was transferred to the Borough Fund in aid of rates. Would Mr. Roberts let us know on what principle this is calculated? Is it a compulsory charge? If so, it should form part of the standing charges. In

Johannesburg, under the term Assessment Rate, an annual sum of something between £12,000 and £15,000 is taken, and forms part of the standing charges, and this is over and above what is appropriated directly for the relief of rates, which in 1909-10 was as high as £86,084, which of course did not form part of the standing charges, but what was regarded as net profit. I would like Mr. Roberts to touch upon this aspect of his Department, as it greatly affects the question of tariffs.

Having made this rather long preamble, for which I apologise, I will now proceed to the question of the Tariffs.

Dealing firstly with Scales 1, 2 and 3 of the Durban tariffs, the power consumer taking an unrestricted hour supply obtains electric current at considerably more favourable rates than a large lighting consumer. In my opinion, a large consumer who uses electricity for power at the same time as a large lighting consumer uses it for lighting should pay the same. Take the following two cases for example:—(a) A large printing works taking current during the hours 5 p.m. to 11 p.m., and the current used for lighting small compared with that used for motors, etc.; (b) a large hotel, which utilises the current almost exclusively for lighting purposes. The maximum demand in (a) the same as in (b), and the units consumed the same in each case and both sufficiently big to entertain the idea of installing their own plant, it must be obvious that it would be impossible to sell to (b) at 5½d. and to (a) at 2d. downwards to ½d. per unit; it would be commercially unsound and unfair. This differentiation as in Durban could not apply to the numerous consumers with which the present writer has to deal. Hotels, boarding-houses and residential chambers would operate on three scales, namely, 1, 3 and 6a. For its complete requirements each such building would require:—

1. Two rate meter for lighting at 5½d. and 1d.
2. Ordinary meter for power from 2d. to ½d.
3. Ordinary meter for special circuit for heating and cooking at ¾d. per unit.

This arrangement involves four systems of measurement by three meters and a time switch, and although the danger may be a small one, there is the possibility that current for lighting may be improperly taken from the cheap rate mains. Taken individually, the tariffs are no doubt simple, but in actual practice the measurement of a large hotel as illustrated is complicated and expensive, and the complication would be increased in the case of a three-wire system. Such a system of tariffs also involves special wiring. It is observed that in the figures of consumption given by Mr. Roberts, none are shown as ¾d. units, in which case it looks as if the hotels up to 1915 have not availed themselves of the ¾d. tariff for heating and cooking.

In connection with the tramway supply, it is observed that the load factor is 24% and units consumed 3,744,880. The load factor of the Government supply is not given, but the consumption is approximately the same, 3,307,927. Does the maximum load of the Tramways occur at the time of maximum station demand, and if not, does the Tramways Department obtain any benefit from this diversity factor? Do these conditions apply to the Government supply at ⅝d. per unit?

Taking Scale (3) and working out the price that a power consumer would pay per unit with a consumption equivalent to the Tramways, the price is .504d. per unit. Thus a power consumer with unrestricted hour demand has much better terms than the Tramways or the Government supply, and this independent of load factor. Would Mr. Roberts explain the justification of such differential treatment, or whether it is a question of policy irrespective of the financial aspect?

Dealing now finally with the domestic tariffs. The Norwich system adopted by Mr. Roberts to enable current to be sold at two rates without the costly time switch is one of many commendable ways of side-tracking the manufacturer of meters.

Now, ⅝d. per unit less 10% is approximately .56d. per unit. The following are figures of consumption submitted by Mr. Roberts:—

	1915.	1916.	1917.
Units consumed per annum	689,000	930,000	1,252,000
Revenue at ⅝d. per unit less 10% ...	£1,620	£2,680	£2,920
Total revenue of Department	£104,554	£116,008	?

The revenue from ⅝d. units is small compared with the total revenue of the Department, and I would like to ask Mr. Roberts what has been the expenditure involved in giving the supply (including the proportion of Capital Charges), and whether he is of the opinion that it is a financial proposition to supply at ⅝d. less 10% over a widely distributed area and in some cases sparse population? If this be not the case, has the increased sale of 5½d. units more than made up any loss? In some of the 89 suburbs of Johannesburg it can be shown in some cases at big distances that distribution costs for lighting are more nearly 6d. per unit, and, as in very small towns, the distribution costs are often the greatest portion of the total costs. The Municipal Electrical Engineer must be particularly careful to keep his eye on the ultimate result of the ⅝d. units becoming the largest portion of the demand. Mr. Roberts thinks the average domestic consumer can take 6,000 units per annum, and that, if 7,000 consumers took this there would be a demand for 42,000,000 units per annum. The figure of 6,000 agrees with the experience available to the present writer. As a matter of interest it might be mentioned that the Johannesburg Municipal

Council received an offer recently for 5,000,000 units at ¾d. per unit on a restricted hour supply from the Victoria Falls Power Company. This Company is one of the largest electric steam power companies in the world, and has ideal conditions for generation, with cheap coal and water and a most perfect system of demands from about 80 consumers, some of whom take as much as 60,000,000 units per annum at 80% load factor. The price paid per unit, according to the scale of prices gazetted, is about .625d. per unit, and the profits of the Company are not fabulous. Turning back to the question of a domestic consumer, I have taken two cases for consideration: 14,706,922 units at ⅝d., with the present amount of lighting and power units at 2d. and 1d. and 5½d., would give an output for these purposes equal to the total output as shown for 1915, namely, 17,659,922 units, and the revenue per unit would be 1.2d. per unit. In Mr. Roberts' figures 1915 show a total cost of 1.09d. per unit. The difference between the revenue per unit and the cost per unit would not pay the 4% required by the Corporation as contribution to the Borough Fund. Of course conditions would be different and costs would be lower, but the overall load factor 1915 was 47%, and it is questionable whether the load assumed to grow for lighting, heating and cooking would be of such load factor as 47%; then again the total load for 1915 deals with some very large consumers, such as the Tramways, the Government, etc., and the calculation of the ⅝d. units is assumed distributed among the 7,000 relatively small consumers. Mr. Roberts' views will be of great value to us.

Taking the growth to 42,000,000 units as predicted possible by Mr. Roberts, the revenue per unit will be reduced to .8d. per unit, and the important question is as to whether this is commercially sound. The following are extracted figures from the Durban accounts, 1916:—

Works cost generation	.397d. per unit.
Works cost distribution	.31d. per unit.
Works cost house services	.042d. per unit.
Standing Charges, such as interest renewals, sinking fund and loan charges	.386d. per unit.
	1.135d. per unit.

This is exclusive of rates, rents, departmental charges, management and general expenses. It might be stated that the 1.135d. per unit only represents such charges as are necessitated by the growth of load, necessary loans for further station and distribution plant, and the actual cost of each unit at the works and on the distribution. The above figures would of course be reduced by increase of consumption, but I would like Mr. Roberts to express his views on the average revenue of .8d. per unit. In submitting these notes it is only fair to note that Mr. Roberts states:—

"A word or two may not be out of place in regard to the effect of the heating demand on mains. Those who have hesitated to cater for this service on account of the large demands on the mains have had their fears well founded, especially in the case of D.C. systems. In fact, I should think it is not going too far to say that D.C. systems had better leave it alone, or else get changed over to A.C. as soon as possible."

We shall be glad to have Mr. Roberts' experience up to date relative to the commercial aspect on A.C. systems. Arising out of some of the points I have brought forward in the discussion and as an attempt at simplicity, the following tariffs are under consideration by the Municipal Council of Johannesburg, but decision is deferred owing to the war. It will be seen that the proposition is to sell electric current in accordance with periods of the day corresponding to the times of maximum and the minimum demands of the system, and, generally speaking, independent of the purposes for which current is used, special cases being dealt with as they arise.

Summary of Suggestions with regard to Future Revisions of the Electricity Tariffs:—

FOR LIGHTING OR POWER.

	Per Unit.
High Rate, from 5 p.m. to 11 p.m.:—	
First 1,000 units per month	6d.
All over and above 1,000 units per month ...	1d.
Low Rate, from 11 p.m. to 5 p.m.:—	
First 10,000 units per month	1d.
Next 10,000 units per month	$\frac{7}{8}$d.
Next 10,000 units per month	$\frac{3}{4}$d.
All over and above 30,000 units per month ...	$\frac{1}{2}$d.

All consumers, with the exception of private householders, boarding-houses and residential flats, taking electricity for 24 hours of the day, will be required to instal two-rate meters. The cost of the extra meters and time switch will be charged to the consumer, but the Council will bear the cost of fixing.

Consumers taking electricity only at the low rate (from 11 p.m. to 5 p..m) will be required to pay a minimum monthly charge of 5s.

PRIVATE HOUSEHOLDERS, BOARDING-HOUSES AND RESIDENTIAL FLATS

	Per Unit.
For a consumption up to 4 units per room per month	1d.
For all consumption exceeding 4 units per room per month	1d.

NOTE.—In the case of private houses, no house to be regarded as being less than a 2-roomed house and none greater than a 12-roomed house.

SPECIAL TARIFF FOR ELECTRICITY FOR HEATING WATER.

For heaters taking current for 24 hours of the day:—

For 250-watt heater, a flat rate of	7s. 6d.	per month.
For 350-watt heater, a flat rate of	10s. 6d.	per month.
For 500 watt heater, a flat rate of	15s. 0d	per month.
For 700-watt heater, a flat rate of	£1 1s. 0d	per month.

The aforementioned tariffs not to apply to:—

(a) The accumulation of electricity by means of batteries for use on the peak load.

(b) Consumers having electric plant of their own and not taking complete supply from the Council's mains.

Special prices for large industrial consumers as circumstances arise, and in all cases the question of the cost of distribution to be a matter of consideration.

For heating of churches and halls used on Sundays, such terms as may be agreed upon between the consumer and the Council.

Councillor CRAWFORD (Bloemfontein) said he had great sympathy with the proposal of adjusting tariffs, so that commercial and industrial undertakings could be fully catered for and every facility offered so as to encourage industrial expansion. He quoted from their tariffs at Bloemfontein, which, he said, were again under discussion. They had an industrial standing charge of 7s. 6d. per h.-p., then a flat rate running from 1½d. per unit by a reduction of one-sixteenth down to one penny per unit, depending on the consumption, and this rate they particularly desired to still further reduce. As regards wiring, they made a charge of £3 whether for light or power, irrespective of position, and as a means of encouraging the use of electricity the Council hired out at a charge of 1s. per month appliances, such as kettles, irons, etc., which had been found very beneficial.

Councillor GILBERT (Harrismith) said that to him as a layman it was a revelation that after a certain point had been reached they could supply power on a large scale actually below the average cost of production. On the present basis of supply at Harrismith the cost of production was high, but if they had a large consumer of 70-h.p. they would be able to supply them at a figure which would reasonably approach the cost of steam power, and that was an educative lesson. One point raised by Colonel Dobson was the question as to whether it was just or unjust to supply an undertaking with light at 6d. and power for three farthings. That was where the competition of steam power came in for large establishments, and his experience as a miller was that whilst it would pay him to buy light at 6d. rather than run a small steam set, he would require power at three farthings to make it worth while to scrap his old steam engine.

Mr. POOLE (Durban) said that Colonel Dobson hit the mark when he spoke of the appropriation of profits. Under the Durban Act the proportion was up to a mixmum of 4 per cent. of the capital outlay per annum, and he did not see why the electric light consumers, who had to pay sufficient for their current, should also pay extra taxes indirectly through their electric current accounts. He did not see why the tariffs could not be reduced so that they did not pay on the full per cent. which was appropriated. Mr. Poole quoted figures relating to the various Municipalities, which contributed towards the rates, and added that there was another matter to which Colonel Dobson had referred, and that was the effect of the diversity factor in assessing charges. The diversity factor should come into play in the adjustment of tariffs.

COMMUNICATED REPLY BY THE PRESIDENT.

In reply to Colonel Dobson, the points he raises cover a great deal of ground, but I will try to answer them without taking up too much space in the proceedings.

Dealing first with the question of the Durban Corporation's methods of providing for redemption of loans: The Corporation up to the year 1913, with one unimportant exception, raised all their loans to become repayable in 50 years, and the Electrical Department's finances provided for sinking funds to be set aside so as to meet the liability of repayment at the end of such period. But in 1913, owing to the stringent condition of the money market, a five-year loan was raised with the clear understanding that it would be refloated at maturity, and it was hoped at lower interest. This, then, accounts for the fact that the Electrical Department's share of this loan (£85,000) will fall due to be refloated (not liquidated) next year.

In regard to the criticism that the Accumulated Renewals' Fund only amounted to £10,000 in 1915, it might first of all be said that this year (1917) the total amount of such fund will be about £45,000, but I attach no very great importance to this, because large amounts, averaging at least 4 per cent. on the loan funds, have every year been set aside out of revenue to write off obsolete plant, provide depreciation, or to buy new plant, with the result that the loan indebtedness is only £415,000, and there is a Sinking Fund available of nearly £40,000 invested at interest. The comparison which is made by Colonel Dobson of the capital, renewals and redemption allowances, between the Johannesburg and Durban undertakings, will, I think, demonstrate that the Durban concern is not over-capitalised, and consequently that depreciation and renewals funds have been properly provided for. The Johannesburg loan liability is £959,295 against the Durban liability of £415,000, while the units sold are 25 million against 20 million.

In regard to the contribution in relief of rates, the procedure in Durban is to tax all the trading departments on this account to the extent of 4% on their loan liability, and it is considered as one of the items of expenses which are included before net surplus is reckoned.

Colonel Dobson then turns to the question of Tariffs, and points out that in Durban the power customer gets current very much cheaper than the lighting customer, as, for instance, the owner of a large hotel. Such a criticism could, I suppose, be levelled against 99 out of every 100 electricity undertakings the world over. And the reason is that the purely lighting consumer takes his maximum for from three to four hours or less per day, while the power consumer, in the vast majority of cases, uses power for eight to ten hours per day and at "off peak" times. Such a criticism cuts at the root of all electricity tariffs and attacks such widely accepted general principles that I do not think I need answer it further, except to say that Colonel Dobson's comparison between a hotel and a printing establishment has no point to it. His implication is that the printing works uses current at the same hours as the lighting peak occurs. Even if it did, my answer is that such a power consumer is the exception, and it is unnecessary to provide a tariff for power specially to take into account exceptional cases. Most ordinary electric power users cease consuming at 5 p.m., just before the lighting load begins. But as a matter of fact, the average printing works uses current almost throughout the 24 hours, *except* at the lighting peak, because most newspapers run a printing works all day and stop at 5 o'clock till they go to press at from 9 p.m. to midnight, so that their demand, taken as a whole, is very favourable, fitting in with the lighting peak very well.

Colonel Dobson then goes on to criticise the complication of our tariffs, pointing out that a large hotel would require four meters if it took current for lighting, heating and power. That is quite true, and it is freely admitted that the attempts in Durban to extend the use of current has almost compelled us to offer special terms for special classes of supply, and a more simple system and one more applicable to all conditions is to be aimed at and will doubtless one day be introduced.

The next criticism is of the tariff to the Tramway Department being higher than would be offered to one single power customer of the same demand. Surely it does not need to be pointed out that to supply a bulk of current to one customer through one cable to one spot is a very different proposition to supplying a tramway system at 550 volts direct current through 20 or 30 cables all over a scattered town. Further, a consumer of this volume of electricity would take current at 3-phase, which is not only much cheaper to distribute, but cheaper to generate also than direct current. This is why the Government, who take 3-phase current in bulk at two or three points, are supplied cheaper than the tramways.

Colonel Dobson then turns his attention to our Norwich system of supplying the domestic consumer with current at ⅝d. less 10% after a certain number of units has been paid for at the higher rate; and he mentions as a matter of interest the offer the Johannesburg Municipality received from the Victoria Falls Power Company to supply five million units at ⅝d. per unit. Such an offer as this is apt to be influenced by special considerations, such as what the customer can provide the service for himself. It also must be remembered that the Company in question has probably heavy capital and administration charges to pay, for it is supposed to have paid one million pounds for the rights to use the Falls whose name it bears, but which renders no other service to the Company. Colonel Dobson asks what has been spent in Durban in distributing mains to win an output of 1,250,000 of the low price (⅝d.) units. Such a figure is almost impossible to arrive at, and it would not be worth getting out at the present time, because in the present development stage of our heating business there is no ratio between revenue and capital expenditure on mains, which could be arrived at, that would be any guide, to what this ratio might be expected to be when the business extends to one of really large dimensions. I may say, however, that at normal (pre-war) prices of mains the single-phase high tension supply system, whereby transformers can be put in at every street corner if desired, there is no need to fear that the revenue to be got from an extensive cooking-load will not easily pay for investment in distribution, especially in well settled districts. The diversity factor of cookers is very good indeed.

Colonel Dobson then proceeds to forecast the result on the Durban Undertaking's revenue when the Durban householder uses electricity to the amount I foreshadowed in my contribution to the discussion, viz., 6,000 units per annum per consumer, when the total consumption from domestic use would amount to 42 million units per annum, and the average revenue would then fall to as low a figure as .8d. per unit. Colonel Dobson asks me to express my views on an average revenue of .8d. per unit. Colonel Dobson overlooks that by the time the householder has been educated to the use of electricity to this degree, other demands for current will have enormously grown till the total output from the station ought certainly to be not less than 80 million units, for at the present time the industrial applications of current are leaving the lighting and heating supply far behind, but, even assuming that the average revenue does fall as low as .8d. per unit, I am by no means perturbed at the prospect. The improvements in Power Station plants already foreshadowed by experimenters justify us in assuming that in a few years we shall produce 1 kilowatt hour (unit) for 1½lbs. of coal, instead of 3lbs. as at present, or, in other words, that in the future Durban Power Station we shall turn out 45 million units a year by burning no more coal than we now turn out our 22 million units for.

As to Colonel Dobson's request for our experience of catering for a heating load from A.C. supply, I have already indicated the case with which this can be done. A list of tariffs it is proposed to put in force in Johannesburg is given in conclusion by Colonel Dobson, and as, presumably, criticism is invited, I would venture the following:—

At the outset I would say that I am disappointed that though the tariff has the merit of simplicity, which is a good point in its favour, it does not appear to me to be based on any reasonable basis. I was particularly surprised at the rate offered to lighting customers between the hours of 5 p.m. and 11 p.m.—peak hours. After 1,000 units a month, current is to be sold at as low as 1d. per unit. If the two-rate system of charging is adopted, then one has stated a principle and it should be adhered to. And, further, it seems to me to be grossly unfair to the little shopkeeper, who never gets near 1,000 units a month, to give the large hotel or store such favourable terms for his large consumption. I can understand charging 6d. during peak hours and 1d. at other times, but I can discover nothing in the conditions of electricity production which allows of such a sudden drop in charges for current taken in peak hours as from 6d. to 1d.

In regard to the charges for "off peak" service, I note that Colonel Dobson proposes to charge as low as ½d. for current after 30,000 units a month are consumed. Now presumably these ½d. units are expected to pay him. That is to say, that the higher priced units have paid standing charges and that the ½d. units yield a small profit on the actual working cost. If that is not the case, then he will have made a loss on every one of those units. But presumably he can profitably generate and deliver at ½d. to the large power customer. The question I would ask him is: "If he can do this to the large power customer, why can't he do it for the householder?" (leaving out for the moment the present difficulty of finding capital for the necessary mains extensions). It is no answer to say that it costs more to distribute to the domestic user. That is only saying that the capital charges are high. Those charges, of course, must be defrayed in any case, and they are supposed to be defrayed by the 6d. units. If they are not, then charge 7d. or more, but once they are defrayed then there is only the mere cost of producing current to be provided for, and if the large consumer can be supplied at ½d. then my contention is so can the householder, and that has been the principle underlying the Durban charge.

Colonel Dobson takes me up on the unfair differentiation existing in Durban between the Power consumer and the Tramways as regards charges. Let us see how his charges will work out in Johannesburg in this respect. I suppose the Johannesburg trams use at least 6,000,000 units a year, and I believe the charge made by the Electricity Department is 1.379d. per unit.

If he were to put the Tramways on the proposed new basis, like any private power user, then they would pay as follows:—

157,860 units per month between 5 p.m. and 11 p.m.
342,140 units per month at other hours.

	£	s.	d.
1,000 units at 6d.	25	0	0
156,860 units at 1d.	654	0	0
10,000 units at 1d.	42	0	0
10,000 units at ⅞d.	36	0	0
10,000 units at ¾d.	32	0	0
312,140 units at ½d.	648	0	0
	£1,437	0	0

which is an average of .69d. per unit, or considerably less than half what is now the charge to the Tramways. Colonel Dobson asked me how I reconciled such a state of affairs in Durban. May I ask him how he is going to reconcile it to his Johannesburg Committee, seeing that he thinks it so unfair in my case? And, moreover, as this would be the charge he would have to make to any large consumer, how will he explain it in view of the much larger figure asked by the V.F.P. from his own Municipality for a bulk supply during restricted hours?

I note also that he proposes to refuse his tariff to those who instal batteries to be charged from the mains in "off peak" times for discharge at the times of "peak." In the first place, I doubt if he has powers to so refuse, and if he could get them it would not be fair to enforce them. But in any case, why should he discourage a customer from taking current at "off peak" hours? I thought his object was to reduce his peak load. The only implication is that his prices on the peak are evidently highly profitable to him.

Generally, I expected a tariff from a man of Colonel's Dobson's undoubted abilities better founded on some recognised principle. He discourages "peak" motive power load by making it practically impossible for the small power user to use current after 5 o'clock, even occasionally, which is a great hardship, and he discourages the peak altogether for the domestic user and the very large lighting customer.

But the greatest objection to his scheme of charging is that nearly all the charges except the domestic supply is made with the evening peak as the first consideration, whereas in many large towns where electricity has been well taken up the evening peak is practically a thing of the past, as it is in Durban. The merely lighting load (which causes the evening peak—so great a bugbear to Col. Dobson) is so inconsiderable compared with the larger applications of current that the time may not be far distant when a revolution will occur in tariffs and we shall offer special low rates for lighting current to encourage the use of electricity in the evening, and so I think it a pity to start a brand new scheme of charging based on a condition of the industry which in many towns has disappeared and ought soon to disappear from all.

There is only one ideal scheme of charging which is fair, simple and sound. Charge a minimum sum per month to cover standing charges, and the bed rock price based on works cost for current consumed, whether it is to the 5-roomed cottage or the tramway system. The time for such a universal tariff is not quite yet, but it looms largely in the distance.

I would like just to add a word or two in reference to Mr. Gilbert's (Harrismith) remarks as to the possibility of supplying certain consumers whose demands are of such a nature as to be particularly favourable to the electricity supplier at a figure less than the average cost of production. After all, that is only what one might expect, for it simply means that the cost of supplying a special additional demand is much less than the average cost of the whole of the demand. Of course, one would not charge even a power consumer at exactly what his supply costs to produce. One would always aim at a reasonable profit, which would go to help other consumers, who have to be charged at a higher price—the lighting consumer, for example.

At this stage the Convention adjourned for the day.

VISIT TO DURBAN POWER STATION AND TELEPHONE EXCHANGE.

In the afternoon a visit was paid to the Durban Corporation Power Station at Alice Street, the party being conducted over the works by Mr. Roberts and other members of the staff. The adjoining Car Sheds were also inspected through the courtesy of the Tramways Manager (Mr. H. M. Thomas), and the visit proved a most interesting one.

The party then proceeded to the Municipal Telephone Exchange, being conducted over same by Mr. W. Manson (Telephone Manager).

MR. POOLE'S PAPER.

In the evening, at the invitation of the Engineering Section of the Natal Society for the Advancement of Science and Art, the members and delegates attended at the Durban Technical College to hear a paper on "The Union of S.A. Municipal Electrical Undertakings," by Mr. E. Poole (Assistant B.E.E. of Durban). The paper is incorporated at the end of these proceedings.

At the close of the lecture a brief discussion took place, in which Colonel Dobson and Messrs. Bellad-Ellis and Sankey took part, and Mr. Poole was very heartily thanked for his work in compiling a record of S.A. Municipal electric undertakings.

WEDNESDAY'S PROCEEDINGS.

In response to an invitation from the Mayor of Pietermaritzburg, the members and delegates entrained for the City on Tuesday evening, and arrived in the capital of the Province shortly before 8 o'clock on Wednesday morning. The delegates were received at the station by representatives of the Municipality and conveyed to the Imperial Hotel, where an official breakfast was served. Those making the journey were as follows:—

MEMBERS:—The President (Mr. John Roberts), W. Bellad-Ellis, E. Poole, M. McDonough, G. A. Stewart, R. A. Stoker, W. H. Blatchford, Thos. Jagger, T. Millar, A. Munro and B. Sankey.

DELEGATES:—Councillors J. Crawford, S. Carter and Smith Hudson.

VISITORS:—J. W. Kirkland and C. J. Everatt.

RAILWAY ELECTRIFICATION.

At 10 a.m. Mr. J. W. Kirkland, of Johannesburg, gave a lecture on "Railway Electrification," the Rinkoscope, with its apparatus, having been placed at the disposal of Mr. Kirkland for the occasion.

About a hundred and fifty persons were present at the lecture, and among those present were the Mayor and Deputy-Mayor, the Borough Engineer and several representative electrical and mechanical engineers, besides a sprinkling of business men.

The President of the Association, who briefly addressed the gathering at the outset, congratulated the Municipal Electrical Department and the Corporation on their decision to invite delegates to the City, and he also thanked the Mayor and the Town Council for extending this invitation, and for the hospitality being shown to the delegates during their stay in Maritzburg.

A feature of Mr. Kirkland's lecture was the very excellent cinema views showing electric railways in America and an abundance of educational pictures dealing with the construction of the latest electric locomotives. As a cinema show alone the lecture was an eye-opener for everyone present. The views were most convincing as to the practicability of electricity as a means of railway traction, and, coupled with the very comprehensive character of the data supplied by Mr. Kirkland orally, all doubt as to the future of this somewhat new feature of modern railway progress was dispelled.

Mr. Kirkland told a very graphic story of the Chicago, Milwaukee and St. Paul Railway, which is the largest and most important instance of the application of electricity to railway operation, and which he recently visited and inspected.

Mr. Kirkland described the venture as a very remarkable engineering triumph, which he said might perhaps at no distant date have its counterpart in South Africa; especially was this so in view of the interest being displayed by Sir William Hoy and others in the possibilities, particularly as regards Natal. One outstanding feature that was ever kept in view throughout the lecture was the greater efficiency obtainable from the use of electricity as compared with coal, and in addition to this important factor Mr. Kirkland assured his audience that with electricity greater comfort was ensured for passengers as well as increased safety for the staff. Moreover, it had been found that in many cases the staff required was not nearly so numerous, for, by the use of sub-stations, trains could be automatically regulated just as safely and efficiently as if human means were available.

In further emphasising the utility of electricity for locomotion, the lecturer mentioned that he had had an opportunity of travelling over some of the lines in question which afforded the severest test.

The films subsequently shown told their own story, and a very interesting item was the test made of steam versus electricity at one point of the journey. The picture showed a steam engine pulling, with difficulty, three coaches up a steep grade, and immediately behind followed an electric locomotive drawing, with ease, eleven such coaches.

During the course of his recital of facts and figures connected with the line being dealt with, Mr. Kirkland said that in one respect the Chicago-St. Paul Railway was unique, for, apart from being the biggest thing attempted in this direction, it was remarkable for employing the highest direct current voltage thus far practically applied. Another striking feature of this railway from the point of view of Natalians was the fact that electricity has entirely superseded steam traction in crossing the Rocky Mountains. The ease with which curves were negotiated by the electric train as depicted by the film must have impressed those who have done much railway travelling in Natal.

Mr. Kirkland affirmed that another great feature about the electric train was that only half the quantity of coal required for a steam train was needed, and that on the particular line dealt with the cost of the electric current delivered by the Montana Power Company was one farthing per kilowatt hour. In his opinion the cost of an electric train on the Natal railway system between Durban and Estcourt would be considerably less than at present, and moreover, as was the case in America, it might be found possible to utilise some of the waterfalls which were conveniently situated. He predicted that as electricity superseded steam, which it was predestined to do, farmers adjacent to the railways would be able to derive considerable benefit therefrom, and the same would apply to industries. Generally speaking, he said, it had been found more economical for electric railway companies to purchase their current from other companies who were supplying the needs of other branches of industrial activity.

Whatever might be the outcome of the present investigations that were being made as to the feasibility of electric traction in South Africa, Mr. Kirkland strongly urged that in any experimental work which might follow, the severest tests should be made under the most difficult conditions. The reason he had selected Natal for his lecture was, he said, that if water power were not found sufficiently effective there were several coalfields in the vicinity of the railways which could supply the coal necessary for generating the electric current.

At the conclusion of the lecture the Deputy-Mayor proposed a very hearty vote of thanks to the lecturer, and said that they had all seen what had been done in the United States, and there was no reason why what had been found to be practicable and successful in America should not be just as successful in Natal.

The vote was carried with acclamation.

VISIT TO POWER STATION.

After partaking of light refreshments kindly provided by the Mayor, the delegates were conveyed to the Power Station, where, under the direction of Mr Munro (the engineer) and his staff, they were conducted over the works, stores, etc., the visit proving most enjoyable.

CIVIC LUNCHEON.

Subsequently a civic luncheon was accorded the members and delegates at the Imperial Hotel. The Mayor presided, and the occasion was rendered unique by the presence of Maritzburg's two lady Councillors, while the local members of the Legislative Assembly and members of the Provincial Council were also present. The Mayor gave the toast of "Our Guests" in very eulogistic terms, and this was replied to on behalf of the Convention by the President in an equally happy speech.

At the conclusion of the luncheon, cars were in readiness to convey the guests to various places of interest in the Borough, and the party subsequently entrained for Durban at 4.30, cheers being given by the members of the Convention as the train steamed out.

THURSDAY'S PROCEEDINGS.

MEMBERS PRESENT:—The President (Mr. John Roberts), B. Sankey, A. S. Munro, H. Brittle, P. J. Gold, T. Wolley-Dod, Colonel J. H. Dobson, T. Millar, T. Jagger, W. H. Blatchford, R. A. Stoker, G. A. Stewart, M. McDonough, G. H. Swingler, W. Bellad-Ellis, E. Poole and P. Finlayson.

DELEGATES PRESENT:—Councillors E. W. Gilbert, J. Crawford, S. G. Francis, E. Hopper, Smith Hudson and C. J. Bischoff.

VISITORS:—W. Odgers (Johannesbrug), Arthur du Pasquier (Johannesburg), J. Donelly (Pretoria) and C. J. Everatt (Johannesburg).

Councillor SMITH HUDSON (Port Elizabeth) informed the Convention that when the Convention decided to hold its next meeting at Port Elizabeth, he communicated with the Mayor, and he had now received the following telegram in reply:—

"Please extend hearty invitation to Association to meet here next year."

Councillor Hudson added that he was sure that Port Elizabeth Municipality would do all they possibly could to make their visit a truly pleasurable one

The PRESIDENT thanked Councillor Hudson for his interest in the proposed visit and his kind words.

On the motion of Councillor CRAWFORD, it was resolved to wire to the Mayor of Port Elizabeth, thanking him for his assurance of hospitality.

The PRESIDENT raised the question of the election of the Council and it was resolved to deal with the matter on Friday.

It was proposed by Mr. SANKEY (Port Elizabeth), seconded by Mr. McDONOUGH (Bethlehem):—"That, in view of the fact that the discussion on "Tariffs" was still in abeyance, Mr. Hamlin's paper on "The Design, Operation and Management of Small Electrical Power Stations," which is down for Friday morning, be taken as read, and that questions arising out of the same should be forwarded to the Secretary for submission to Mr. Hamlin, and that the replies be included in the printed proceedings.

Motion put and adopted.

ADJOURNED DISCUSSION ON "TARIFFS."

Councillor HOPPER (Capetown) expressed a desire for something to be done in regard to the Tariffs question. He also urged that action should be recommended upon the subject of appropriation of profits from municipal electrical undertakings.

The PRESIDENT said that in regard to the question of Tariffs no finality could ever be reached, for that would be a matter which would be left to the discretion of the individual municipalities At the same time, general principles of charging could be laid down, but on the matter of profits it was not at all a bad suggestion that some expression of opinion on that important matter should go from that Convention.

Councillor SMITH HUDSON, of Port Elizabeth, confessed that he might hold different views from many delegates who happened to be members of Town Councils, but he contended that the view he held was a sound one. He held that a successful Municipal Electrical Undertaking cost the ratepayers not a penny piece. Consequently, due consideration should be given in the discussion of any tariffs which were to be imposed on the consumer to see that such tariff would not be indirectly a tax on those who supported the scheme. In Port Elizabeth they had a well-established gas company, and when they started upon their electrical undertaking they raised a loan of £150,000, but no provision was made in the capital raised for any loss incurred in the initial stages of the scheme. In the first five years they sustained a loss in the neighbourhood of £17,000. That amount had been liquidated during the last seven or eight years. In liquidating that debt they had got to bear in mind that probably up to the present they had not 50% of the ratepayers supporting the scheme, so that 50% of the ratepayers of Port Elizabeth had provided the loss entailed in the early stages of the scheme, and it had not cost the other 50% one farthing. The ratepayers were simply the guarantors of the loan. They started off with a tariff of 9d. per unit. Then arose the question of power, and in due time they got larger support than they anticipated, which was a very good thing for the scheme. He maintained, in passing, that although the cry of the lighting consumer might be very fierce and intense, and that he might create disturbance at some of the public meetings, the ratepayers must recognise that there could be no reduction in the charge for lighting unless they had a day load for power, which, although sold at low average cost, would bring them in a handsome income and thereby assist them in reducing the tariff. Port Elizabeth had borrowed money for increased extensions. Up to the present they had made no allowance to the rates, and to his mind to make any allowance for the benefit of the ratepayers—in Port Elizabeth at any rate—would be bad in principle, worse in practice, and he went on to the extent of saying that it would be iniquitous from the point of view of equity. They had just reduced their charge for lighting from 9d. to 8d., and the maximum had been reduced from ten units to five units plus one unit for every £100 house valuation, so that a house of the value of £1,000 would have a maximum of fifteen units. After the consumer had reached that maximum the rest of the current consumed by him was at the rate of one penny per unit, no matter for what purpose it was used.

They had now reached a profit-making stage, and they had adopted a scheme which he would like them to understand was, from his point of view, thoroughly unsound, viz., they were taking revenue and using it for capital expenditure in extending mains, etc. That really represented one penny per unit, so that if they were dealing fairly with the supporters of the scheme in Port Elizabeth, instead of the tariff being 8d., it should be 7d. Therefore they would see that the present consumers were providing mains extensions for those who were just coming in to take electric light, and those that came in later would not only get the benefit of the reduction from the results that were being obtained at present, but they were in the happy position of not having supported the scheme when the tariff charges were so high. He trusted that as their experts and guides in matters of that description they would not lose sight of the fact that there was a possibility of municipalities, in the framing of tariffs and in the handing over of profits, inflicting an injustice upon those who should be most favourably considered. Then he would like to go further as regards power. Their tariff for power up to a short time ago came down as low as one halfpenny per unit. He did not know much about electrical matters, but he was convinced in his own mind, along with Mr. Sankey, that they could not afford to give power at the present stage even to power consumers at one halfpenny per unit. After two years' struggling they had got a tariff through in which the minimum was ¾d. per unit. Their tariff for large consumers was so much at 1½d. and the rest at ¾d. To illustrate the point, he instanced the case of a large consumer requiring 500,000 or more units per annum, and showed what a large difference would be made in the average selling cost per unit in this case as between the minimum price of one halfpenny and three farthings, and how that the average price to such a consumer per unit came down very near to the minimum price. Hence they at Port Elizabeth had thought it wise at the present juncture not to decrease, but to increase their minimum power rate from one halfpenny to three farthings. He thought that there was a danger of electricity undertakings placing too much of the burden on the lighting consumers, who, having supported the undertaking from its earliest days, must have consideration in the development of their electrical undertakings, and he said it with every good wish to the engineers that their fault lay in trying to reduce the minimum prices of current to power users generally to a dangerously low point.

Mr. WOLLEY-DOD (Pretoria) said that there were varying ways of securing the profits, and in Pretoria it was done in the barefaced manner of taking over the whole profits direct. In other towns there were other methods, such as assessment taxes and levies for street rights. He pleaded for general information on the subject to enable them to see the various methods in vogue.

Mr. SWINGLER (Capetown) said that the method in Capetown was in the shape of an assessment on the Power Station, an unduly low charge for current for street lighting, as well as a contrbiution to the rates.

Mr. MUNRO (Maritzburg) said that under the Act under which their first loan was raised it was specifically laid down that profits on the undertaking should only be used for the purpose of reducing the price of current to the consumer, but, of course, whatever conditions were imposed there were always ways and means of getting round them, such as charging for street lighting services at below cost, and increasing the amount charged against the Department for administration charges. In Maritzburg's case in the early days of the undertaking the accounts were always made to balance by adjusting the amount set aside for depreciation. The depression and introduction of the metallic filament lamps in 1909 seriously affected the finances of the electrical undertaking, and the depreciation account suffered, due to increased charges being made against the Department. The year before last was the first year that a genuine profit had been made by the Departmnet, and the surplus had been used in increasing the usefulness of the undertaking in the form of extensions. As things were improving and profits likely to grow bigger, he did not know what they would do, but he felt that the cost of the early day lighting consumer should receive due consideration where there was any reduction in the price of the unit, although the power consumer was the man who helped them to make the undertaking profitable, so that they could relieve the lighting consumer.

Councillor GILBERT (Harrismith) expressed agreement with the principle that all profits from a municipal electrical concern should go to the relief of the consumer. He referred in very glowing terms to the value the Convention had been to him, confessing that it had been the means of him taking an entirely different outlook on many matters which they had discussed. Incidentally he touched upon the question of whether Councils expected their electrical engineers to be financial as well as electrical experts, and expressed the opinion that they did not.

The PRESIDENT observed that the presence of members of Town Councils would strengthen their discussions immeasurably as regards the question of engineers being financial experts. He said none of them were content to be relegated to the technical side, for if they had not a thorough grasp of the financial and commercial aspect, then their engineering knowledge would be of small avail.

Mr. BELLAD-ELLIS (Queenstown) said it was considered a good policy in small municipalities to start at a small charge. He gave some interesting figures intended to prove the unfairness of taking a rateable value as a basis of charging for current. His experience was that electrical engineers were frequently called in as financial experts to their Councils, and rightly, so he said. The electrical engineer should be the manager and a good business man, otherwise nothing but disaster could result.

Councillor HOPPER (Capetown) expressed his desire to bring forward resolutions dealing with tariffs and appropriation of profits, whereupon further discussion was deferred pending such resolutions, which, it was decided, should be taken on Friday morning.

STANDARDISATION IN SOUTH AFRICAN ELECTRIC SUPPLY SYSTEMS.

The President (Mr. John Roberts) then proceeded to read his paper on "Standardisation in S.A. Electric Supply Systems."

GENERAL REMARKS ON THE PRESENT DIVERSITY OF METHODS.

All those who are or have been for any considerable time in charge of an electric supply undertaking in this country or elsewhere must have been struck at some time or other with the extraordinary absence of rules or laid down methods in all the branches of their work. At every turn one finds himself compelled to make a choice between two or more competing things or methods. In many cases the choice is an entirely arbitrary one, that is, there is no merit possessed by one which is superior to another, and either will suit him as well as its alternative. In some cases one finds he has to judge between the exponents of two schools of practice, each of which says he is right and the other wrong. Occasionally he can find nothing which seems to exactly fit his conditions, so he has to develop or make something entirely different to what has been done before. Every municipal electrical engineer in South Africa can call to mind examples of all these cases.

It must be agreed that such a state of affairs is one that should be modified for favour of a more fixed and settled condition. In such a new industry as electricity supply, complete standardisation is not yet possible, nor should it be attempted, for it is quite certain that many important changes, perhaps revolutionary departures from present methods and types of plant, will have been made before the work of electricity supply finally settles down to a cut and dried routine, and no steps should be taken in these comparatively early days to destroy initiative or shut out improvements which are of real value.

But with this qualification we must all recognise that even now the time is already quite ripe for some general agreement between those who are responsible for the extension of electric science throughout the Union of South Africa in the direction of arriving at some uniformity in methods and materials, especially in those cases where diversity not only possesses no advantage, but is positively harmful.

The author of this presentation of the case for Standardisation in South African electrical supply is impressed with the magnitude of the task in covering the whole field, for it is not only in such things as lamp pressures, sizes of wires and cables, etc., on which there is some need to be getting at one mind, but there are such subjects as the presentation of statistics in order to render possible proper comparisons between the performance of the various undertakings, and the amount of allowance to set aside for depreciation of plant and other assets.

ADVANTAGES OF STANDARDISATION.

I am sure I need not dwell long on the great advantage of uniformity to electrical consumers, electricity suppliers, and manufacturers and sellers of plant. In this country the absence of any standards is even more acutely felt than it is in those countries where plant is manufactured, because suppliers are obliged to hold large stocks, and the greater the variety of such stocks the more expensive do they become and the greater the chance of shortage in particular lines. One Durban supplier finds it necessary to stock no less than three hundred kinds of lamps of all sizes, candle-powers and makes. It is probably safe to say that half these varieties could be cut out without detriment to anyone if we could only come to some understanding as to the most suitable kinds for our requirements. An engineer who designs a new plant, be it for a colliery, a factory, or a town, and who departs from the usual standards in regard to system or kind of plant without some very weighty reason lays the concern under a disability which will be a continual handicap for the period of its life, for the replacements will be expensive and perhaps difficult to obtain. Probably the electrical industry has suffered more from faddists than any other. I remember asking one engineer of a municipal plant why 115 volts had been chosen for the lamp pressure. "Probably," he said, "because the designer could not buy a 117½ volt lamp." Take the case of a consumer requiring a motor. At present he must consider the following before he can make his purchase:—

1. A.C. or D.C.
2. Pressure.
3. Number of phases.
4. Periods.

It will be a fine thing for the electrical industry when anyone wanting a 5-h.p. motor need not specify for anything else except the size of the pulley.

In this paper I propose to divide the subject into two divisions:—

1. Systems.
2. Plant and Systems.

I shall leave for the present the consideration of uniformity in statistics, accounts, wiring rules, etc. Other members of our Association will, I hope, at some future Convention deal with these important branches of our business. I know that Mr. Sankey, of Port Elizabeth, is particularly interested in these subjects, and perhaps the paper Mr. Poole is reading at this Convention will give him material for a paper. I am certain that Mr. Poole's paper will be of great value to us all as a record of electrical municipal undertakings in South Africa as they are to-day.

1.—Systems.

Under this head I propose to deal with pressures of supply, kind of current, etc., and I think it will be agreed that to reduce the number of the kinds of lamps, fans, heaters and other appliances must be a desirable achievement. Moreover, if we look forward to the day when the whole country is covered with power lines, then a great deal of waste will have been avoided if uniformity of system has been adopted at the various generating centres.

2.—Materials.

In dealing with this division of the subject, I shall not make any attempt to cover the whole ground. The Standardisation of everything we use is an impossible ideal, and the more we attempt to do the less we shall probably achieve, but, as I stated in the address I had the honour of making you at the commencement of our Convention, we now have a splendid opportunity of conferring together on our requirements, and if we can arrive at some joint understanding and agreement on a few points, our recommendations are likely to carry weight with the influential committee now considering the subject of Standards in Johannesburg. In any case, it may not be necessary for us to wait long if this Committee's deliberations become too protracted, and I see no reason why we ourselves should not put something into force in the hope that our example will be followed in private plants such as industrial establishments owning their own plants, coal mines, etc.

On the general question of Standardisation in this country, there are one or two things to be said before tackling the subject. There are, of course, already a large number of plants existing, and they are tied up to an established system and pressure which in most cases they will not depart from. In some cases, however, where the pressure, or periodicity, kind of current, etc., may seriously militate against the growth of the output, then a change to something more in conformity with accepted standards may be found to be profitable, and it would be expected that should we be fortunate enough to come to some conclusion on any points, everyone would follow them in any important extensions of plant and mains.

Suppose, for instance, we have a small direct current station with a demand for power arising of such magnitude, or at such a distance from the works, that its existing system is unable to meet it. It would then be necessary to provide A.C. current, and it would be expected that such an extension would be in accordance with the standards we had all agreed to.

I will now outline what will be covered in this paper and what I hope this Convention will find time to consider and if possible come to some decision upon, for recommendation to the Standards Committee.

Systems.

1. Class of current—Alternating or Direct.
2. Periodicity.
3. Number of phases.
4. Generating pressure.
5. Transmission pressure.
6. Supply pressure of distribution.
7. System of distribution network.

Materials and Plant.

a. Sizes of bare and covered conductors for overhead work.
b. Insulators.
c. System of cable laying for underground mains.
d Sizes of cables.
e. Street lamp brackets.
f. Meters.
g. Plugs for heating appliances.

Systems.

ALTERNATING OR DIRECT CURRENT.

The general prevailing tendency towards both the generation and distribution of electricity by alternating currents is noteworthy. About ten years ago many single-phase systems in England were changed over to D.C., but that tendency has long been arrested, and in the recommendations made by Messrs. Merz and McLellan in connection with the reorganisation of the supply of electricity in London A.C. distribution was part of the scheme. We also have the example of the V.F.P. supply on the Rand, which is three-phase 50 periods throughout, and I know of no case of transformation to D.C. by the mines themselves with the exception of hoisting; even here the relative merits of the A.C. and D.C. winder are still a subject of controversy. It is evidently recognised that every reasonable application of electricity is just as well, and in many cases much better done, by A.C. than D.C.

In this connection it is interesting to note from Mr. Poole's paper that the small undertaking at Paarl, consisting of only 150 k.w. installed has adopted this system, viz., three-phase 50 periods, and I think the designer is to be congratulated on making such a progressive break-away from usual methods.

The great advantages of A.C. can be summed up as follows:—

1. Easier and cheaper transmission and distribution owing to the use of static transformers.
4. Simpler and more reliable motors except for lifts and hoists.

The advantages of D.C. are:—

1. The use of storage batteries possible.
2. Adjustable speed motors by field control.
3. Easier for lifts.

Judging from the overwhelming preponderance of A.C. over D.C. in new plants we must assume that the advantages of the former more than outweigh its disadvantages for special cases, and the writer is also strongly in favour of discarding D.C. for a general supply altogether. My task is to persuade the engineer of the small station to take the same view. The greatest advantage D.C. possesses, he will maintain, is that it enables one in a small town to give a 24 hours' service by means of a battery. I agree with him that such a view was quite a correct one to take, say, ten or fifteen years ago, when current for lighting was the principal if not the only application of electricity in a small town. But I think that even in the smallest place a motive power supply should not be considered as hopeless, and in most towns must be expected and catered for. The amount of load, in fact, which can be secured in addition to lighting will largely depend on the efforts made to secure it. If one is content to remain a purely lighting concern with, say, 50 kilowatts of lighting demand and a small battery which keeps current available for a few odd lights, then "well and good," or, rather, "ill and bad." But that is not doing what is plainly the duty of a public electric supply authority, viz., to educate the public to the use of current for power and heat as well as light. If the running cost of a plant is reasonably low, such as it may be with gas engines, there is no reason why an electric heating load should not be built up even in small towns. The housewife in the country dorp wants an electric iron just as much as she does in the cities. Electric heating utensils are fast being improved, and some day every householder will be expecting the town he lives in to furnish him with current at prices to enable him to use them in his home.

I therefore recommend the A.C. System of Generation and supply of current as a current to be adopted in all new plants and for the supersession of D.C. systems as soon as possible, because:—

1. It is cheap and can be extended to cover large areas.
2. It is the cheapest means of supplying power and heat as well as lighting.
3. All small towns should put themselves in a position to cater for power and heat.

PERIODICITY.

Having settled on alternating current supply, the settlement of the periodicity need not take so much time. Though 60 is the standard in some countries, notably in America, 50 cycles per second is the periodicity fast becoming standard in Britain and the Colonies. In this country the Victoria Falls Power Company, and Johannesburg, Durban, Capetown and Port Elizabeth Municipalities have adopted it. It is very suitable in every way, allowing of good turbine and motor speeds.

NUMBER OF PHASES.

Neither need the number of phases take us long to dispose of. Three-phase is recommended to generate and to distribute. For the latter, four wires are required, because lighting connections must be taken from the neutral and one of the phases. Plain single-phase circuits can be run along streets where the load is small, and three wires where only power is catered for. It is, of course, assumed that the neutral will be grounded, for the supply of current to private lighting consumers from circuits not having one leg of the service grounded should be prohibited by law, and I think we should incorporate that condition in our standardisation rules.

GENERATING PRESSURE.

With A.C. systems generation will naturally be at high pressure, and for the larger schemes 6,600 volt seems to be becoming standardised, being already adopted in several South African supply schemes. It is probably not advisable to go higher than this pressure for generation, as the difficulties of manufacturing alternators are thereby considerably increased, with less reliable operation. When a higher transmission pressure is used, then one should step up with transformers, and there are advantages in having the H.T. mains system not directly connected to the generators. For quite small generators half of 6,600 volts (3,300 volts) is probably an advantage. This is also quite a common pressure fortunately.

TRANSMISSION PRESSURE.

For systems covering a moderate area, such as the average South African town, the generating pressures of 3,300 or 6,600 volts, depending on the extent of the area, the amount of the load and the size of the alternators, will be found to be very suitable. Where long branches have to be led out, say, ten miles or over, then the pressure should be stepped up, and I think we should adhere to multiples of 6,600-13,200, 26,400 volts and so on. This seems to be logical and tends to make transformers simpler in construction. By rearranging sections of windings in series or in parallel the same transformers can be used for more than one condition, which is a strong point in this country and likely to appeal to those who import and would like to stock transformers.

DISTRIBUTION PRESSURE.

I foresee that the settlement of a pressure which will be suitable for all conditions and acceptable to all parties concerned will be very difficult. There are a good many points which have to be taken into consideration and conflicting interests reconciled.

1. The pressure should be high to promote economy in mains.
2. It must be suitable for the lamps on the market.
3. It must suit standard heating and cooking appliances.
4. It must be reasonably economical for power supply and suit usual motor voltages.
5. It must agree with the pressures employed in most of the existing undertakings.

It must be remembered that I have recommended a four-wire three-phase network as the standard for low tension distribution, lighting being taken from the neutral and one-phase wire, and power from the three-phase wires.

Referring first to condition No. 5 above, the following gives particulars of the pressures adopted in South Africa up to the present:—

250 volts, 4 towns (Pretoria and Port Elizabeth).
240 volts, 2 towns.
230 volts, 11 towns (Johannesburg).
220 volts, 8 towns (Capetown, Kimberley).
200 volts, 10 towns (Johannesburg, Durban, Maritzburg).
110 volts, 3 towns (East London).
100 volts, 1 town.

Take 240 and 250 volts first. These are uncommon pressures in South Africa, and, as a matter of fact, everywhere else, and it is great pity they were ever introduced. There would be one or two objections to the adoption of either as the standard of South African pressure. First, it is an unusual pressure in other countries, and, secondly, is too high for heating and cooking. Most heaters are made for 100/110, or 200/220 volts. The heaters for the higher range have heating wires already small enough, and a 250-volt utensil is bound to be less reliable than one at 200 volts, and the heating question is one that must not be lost sight of—in fact, should be kept carefully in view. It is significant, by the way, that all the towns using 230 volts and upwards are doing so on D.C. networks, which is in itself sufficient to condemn direct current for South Africa, because for our scattered areas it is clear that the originators were obliged to go to as high pressures at the lamps as they dared, and those now operating the systems must be feeling the handicap severely. With an A.C. system and economical transforming points one could go down to 100 volts at the lamps without spending too much on copper. It would seem, therefore, that the choice must lie between 200, 210, and 220 volts, for there are only four towns employing pressures less than these. Before settling which of the three it should be we have to take into consideration the character of the distribution system. If we adopt 200 volts as the pressure to the neutral, then we get 200 x 1.73 between phases = 346 volts. If we use 220 volts, then wet get 380 volts between phases. Now, as makers of heaters design their apparatus for 200/220 volts, we might decide to go for the highest pressure, but though the writer has had no experience of 220 volts for working, he is inclined to think that on a range of appliances designed for 200/220 the trouble from burnt out heaters is likely to be much more on 220 than on 200, the energy expended being as the square of the pressure and the heat, which has to be dissipated, being therefore nearly 25 per cent. greater in a 220-volt hot-plate than in the same plate working at 200 volts. I think, therefore, it would be better to make a compromise at 210 volts, and there is still another advantage and that is in connection with half watt lamps, which are going to greatly increase in numbers on our circuits. Many people have found that the life of half watt lamps is increased by under-running them (using a 210-volt lamp on a 200-volt circuit) without any serious sacrifice in efficiency. If 210 volts was the standard pressure we could still use the common 220-volt lamp for our half watts if we wished. A 230-volt lamp for working on a 220-volt circuit would not perhaps be so easy to get.

SYSTEMS OF DISTRIBUTION NETWORK.

I have already indicated that with three-phase generation and distribution we are practically forced to the use of four wires for distributors, though of course all four wires need not be taken through every street. The system is, in fact, a very flexible one, and, if there is no demand likely to arise in any particular part of the area, that portion could be dealt with single-phase throughout. After all, there is nothing to be afraid of with four wires, for we already use three wires now pretty extensively. It will mean two wires on each side of the cross-arm instead of two on one side and one on the other.

So much for Systems. The summary of my conclusions is as follows:—

1. Current—Alternating.
2. Periodicity—50 cycles per second.
3. Number of phases—three.
4. Generating pressure—3,300 or 6,600 volts.
5. Transmission pressure—3,300, 6,600, 13,200 and multiples.
6. Supply pressure—210, 363, volts 3-phase.
7. System of distribution—4-wire 3-phase.

Materials and Plant.

This is a most important part of our subject, in fact the one which is actually the most pressing for our consideration. All of us who have had to make purchases in South Africa will know the long weary waiting for plant to arrive from manufacturers in England or other parts of the world. Local suppliers cannot keep adequate stocks here, chiefly because of the extreme diversity of the needs of the electrical market, and it is to make some radical improvement for the better in this respect that our efforts should be strenuously directed towards standardisation. The diversity to which we have referred has been greatly brought about owing to the almost complete lack of co-operation amongst users of electrical machinery, and if our Association can only place to its credit some fruitful work in eliminating the number of useless and unnecessary types and sizes of apparatus and plant, then it will have completely justified its existence.

The author of this paper was some three years ago instrumental in bringing to the notice of the Government of the Union the desirability of appointing a Commission to report, among other things, on the possibility of standardisation of electrical service throughout the Union, and it was only on account of the distractions caused by the war that the matter was shelved. It is hoped that this Association may advance the matter a step by coming to some decision, which if put into practice voluntarily by agreement between Town Councils will go far towards achieving what should ultimately fall under the attention of the Central Government.

I have already in this paper disposed of the question of pressures, systems, etc., which is a large part of the task completed. We now have to deal with plant, mains, etc., and for the present I do not propose to go very far with our proposals, as I recognise the weightiness of the task and would not lightly suggest a course of action which would possibly be disadvantageous to those in exceptional circumstances whose conditions require special types or sizes of plant, mains or gear.

In fact, it would probably be well to leave power station plant out of the scheme, for the present at any rate. For one thing, our total requirements are not large; they are, moreover, very varied, and for some time to come engineers will not want their hands tied in the selection of the best methods of making and delivering current in the cheapest manner, and that most suitable to the conditions of the country. Especially do these remarks apply to the circumstances of the smaller communities, for the writer believes that the last word has by no means been said on this problem.

I have been careful not to go far in this tentative effort in the hope that this short step in the direction of more uniformity will prove so helpful that by next year members will come along with further suggestions so that the scheme may be continually developed and modified as circumstances prove it to be desirable.

(a) BARE CONDUCTORS.

All we shall have to fix in this connection is the sizes of the various conductors we decide to adopt. First of all as to the system of measurement. It is likely that the champions of metric measurement will advocate the square millimetre as the unit of area. Against this there are two arguments, the first being that the British Engineering Standards Committee have adopted the square inch as the basis, and I think it is our business in this country to follow the lead of the Home authorities on such a matter as Standards, especially as it will be of the greatest importance after the war is over to encourage trade with our Mother Country, and we can depend upon it engineering interests in England are quite alive to the advantages of the metric system. A second reason is that we are all very much at home with the square inch as used for sectional area of cables, and as we have adopted the conventional density of 1,000 amperes per square inch, a cable of say ·1 square inch section we immediately think of as being equal to a carrying capacity of 100 amperes.

In turning up the standards of the British Engineering Standards Committee for conductors, I find their specifications only cover cables, and the lowest section in their list is .025 (say a 25-ampere cable). Though we rarely require a cable less than 25 amperes carrying capacity, we frequently require something smaller for light overhead wires and service connections, and, as we are all accustomed to using No. 6, No. 8 and No. 10 s.w.g., I suggest we adhere to these sizes for small wires and begin at .05 for square inch measurements, following the sizes of the B.E.S. Committee.

We thus get No. 10 s.w.g. (.0128 square inch), No. 8 s.w.g. (.0201 square inch), No. 6 s.w.g. (.0289 square inch), .05, .075, .1, .125, .15, ·2, .25, .3, .35, .4, and .5 square inch. These sizes give us an excellent range down to the smallest, which is, in my opinion, safe to use keeping mechanical strength in view.

COVERED CONDUCTORS FOR OVERHEAD WIRES.

I am not aware what the practice is in other towns in reference to the use of a covering over overhead conductors, but I will state here how we came to employ them in Durban and give its specification. In all the districts where overhead mains are used for the L.T. distribution we use overhead conductors for the service connections, and shortly after we commenced doing so we got a case of a workman receiving a severe shock while repairing a roof. We then decided to discard bare mains for this work. Accounts we received of V.I.R. covered wires used in this way were unsatisfactory, as the braiding soon perished, the insulation softened and was soon decorating the wires with ungraceful festoons. So we persuaded manufacturers to make for us a special braided wire, heavily impregnated with waterproof compound, the braid being very closely woven and in three separate layers. After it has been up a few years the water-proofing compound is evaporated out, but the braiding still holds good. It is still in that condition fairly good insulation in dry weather, but one can get a shock through it when it rains. When we run short of this wire and cannot get local supplies we have used the class of wire similar to it, but not impregnated with waterproofing called underwriters' wire—an American product I believe—so called, I take it, because the covering is to some extent non-inflammable, but it is not very waterproof. The standard sizes we use are No. 10 and 7/16 s.w.g., the covering being specified above, and we ask that the weights of the wires finished are:—

For No. 10 s.w.g., about 360 lbs. per mile.

For No. 7/16 s.w.g., about 600 lbs. per mile.

(b) INSULATORS

I see no reason why we should not use a standard insulator for low tension mains. Anything almost will do for the pressure, and in Durban we have for many years used a glass insulator, employing porcelain only for high pressure work; incidentally this has one small advantage in that linesmen cannot then easily make a mistake and make a service connection from 2,500 volt lines in those cases where high and low tension wires may be carried on the same poles, a practice not to be encouraged, but which in some cases is almost unavoidable. The insular, too, we find quite good up to 400 volt circuits is as follows:—

Of glass, 4in. high, 3in. in diameter at bottom of petticoat, screwed to fit wooden bush. Pin to be of galvanised steel, ⅝in. diameter, 9¼in. long, with shoulder to suit 3in. cross-arm, top to be fitted with wooden bush with screw thread to fit insulator.

(c & d) UNDERGROUND MAINS.

This branch of the subject need not give us much trouble, for here again the British Standards are available for our guidance, but I think we should all decide on one uniform method of protection for our mains. In Durban we have used most of the usual forms, viz.:—

1. Armoured and laid direct in the ground.
2. Lead covered and drawn into pipes.
3. Armoured and drawn into pipes.
4. Lead covered laid solid in troughs and filled in with bitumen.

We have now come back to the method of laying direct in the ground, though in special cases, which I need not particularise, these cables are drawn into iron pipes. The system of laying direct in the ground is, we find, the simplest and most reliable and certainly the cheapest. We have recently taken up some cables laid just twenty years ago and relaid them again; though the steel armouring has certainly corroded, it is still in good enough condition to justify us in assuming it will stand for at least another twenty years. The only advantage to my mind in adopting more than one system of main laying is that by that means we can readily identify mains which are laid close to one another, but we have decided this advantage is not worth the expense, and we trust to good records to prevent us cutting into a wrong cable. I therefore suggest that for all underground cables we adopt the B.E.S. sizes and adopt steel tape armouring and lay the cables direct in the ground.

(e) STREET LAMP BRACKETS.

The usual form of street lamp bracket (which is in most cases attached to the poles of the low tension distribution overhead work) is approaching nearer and nearer to a standard, and these articles are being employed so universally and in such large numbers that it is likely to be of advantage to the supplier and user alike if they are reduced to a uniform pattern. The standard specification suggested might embody the following:—

BACK PLATE.—Of cast or malleable iron, suitable for bolting by means of a clamp to a pole from 2½in. to 4½in. external diameter.

BOLTS.—To have one end shouldered and bent up at right angles to take an insulator.

TUBE.—To be of wrought-iron piping ½in. inside diameter. Goose neck shape giving projection from pole to lamp of 18in.

BASE.—To be of brass, screwed on to tube and carrying lampholder insulated from it with durable insulating composition.

SHADE.—To be of enamelled iron 16in. diameter and secured by a brass ring screwed to the base.

(f) METERS.

I do not propose to standardise meters further than to specify sizes. I should propose to allow perfect freedom as regards type and make, but it would be of advantage if users would agree to certain ampere sizes for ordinary service connection, and there should be no difficulty in making quite a few sizes suffice, for it must be remembered that modern meters have wonderfully good accuracy characteristics. One can now buy meters which are guaranteed to be accurate within two or three per cent. at 2% full load, and to be practically right at 5% full load, so that we can measure the current to an installation taking one ampere on a ten-ampere meter and expect to get correct results.

I suggest 5, 10, 25, 50, 100 amperes as standard sizes of all house service meters D.C. and A.C., two-wire and three-wire, single phase and three phase. In regard to construction, everyone might fall in with the suggestion to specify terminals at the bottom and not at the top and perhaps agree to a handle being fitted on the top of the case. Some of the best forms are already fitted with this very useful addition. The device gives some security from damage in handling at a quite nominal additional cost.

(g) PLUGS FOR HEATING UTENSILS.

A standard plug for light heating appliances such as irons, kettles, grills, etc., taking up to ten amperes, is badly required, so that when a customer removes from one place to another his plugs fit, and so that any new appliances he buys can be fitted with a plug which will also suit. The plug which is commonly sold in Durban of ten amperes capacity is a fairly good one—certainly as good as any other so far sold. This leaves out, of course, a very much heavier plug and socket supplied by certain makers with a third "earthing" pin for grounding the utensil. As a general rule the grounding of all utensils is a good plan, but few appliances are fitted with a ground terminal, and until this becomes the practice it would seem useless to use three-pin plugs. In Durban we insist on the frames of all stoves being grounded, but not the frames of small appliances, and I must say there has been comparatively good freedom from troubles from shock even though the bulk of the heating supply is given on 200 volts grounded circuits.

The particulars of this plug are as follows:—

BASE.—Of porcelain or wood, with internal porcelain block. The metal terminals to be fitted with amply large screws for pinching up the two suppy wires, and each fitted with socket for receiving the pin of ¼inch. diameter. The pitch of the centres of the sockets to be ¾in. The base to be fitted with a wooden cover, with internal thread to match thread on the base. This cover must cover up all current carrying parts except the two holes for receiving the pins of the plug.

PLUG.—The plug must have a cocus body and the pins must project for a distance of ¾in. The wires of the flexible wire must be screwed to the interior end of the pin in a particularly solid manner.

It is found that a two-pin plug is better than the concentric pattern, and wood is necessary in the parts likely to get knocked about, as porcelain or anything breakable will not stand the service.

The above is the very modest list of proposals in regard to Standardisation which I think it well to try and get agreed on as a beginning. I have purposely made it a short one. As I said before, I think it better to start in a small way with a few things on which there will, I think, be little controversy rather than to put forward a more ambitious schemes which there might be some difficulty in getting through.

The Discussion.

Mr. McDONOUGH (Bethlehem) expressed the view that to have three-phase A/C instead of D/C, which was so well established in the small towns, where so many meters were installed, would be a very laborious and costly process. He took it that in agreeing to any standards it would not be taken that those who were not complying with the new standards would be expected to immediately alter current supply in case of new work.

Mr. SWINGLER (Capetown) said some years ago at Muizenburg they installed a three-phase A/C plant, and he was responsible for it; also running of the same for several years. They had great difficulty in obtaining sufficient load to warrant a 24-hour supply, and engineers of larger stations should remember that the smaller station was not in the same position, as they had neither the population nor the industries.

Mr. SANKEY (Port Elizabeth) said in considering the question of alternating current for small stations they wanted the smaller station men to give their idea of the difficulties in the way of adopting three-phase. He added that the difficulty to the small station was the battery question, but he suggested that it should be quite feasible to run a small motor-convertor or rotary convertor off the battery in the night time and lock up the station. If they accepted the principle that they could leave a motor generator running at night in a locked up station on suitable drop gear, and alarms in the residence of the staff, they were well provided for.

Mr. SWINGLER (Capetown) said that they considered the proposition of Mr. Sankey and he made a report on it. During that time it was also referred to the Government Electrician, and he (the speaker) thought there was an overhaul loss of about 40%.

Mr. STOKER (Kroonstad) put forward a suggestion that it might be possible to instal a small generating set, and, seeing the advances machinery had made, surely it was possible to have a little petrol electric set to run, say, for 12 hours, and he put it forward as a tentaive suggestion in place of using a battery or (and) rotary convertor.

Mr. McDONOUGH (Bethlehem) asked, assuming they could get that type of machinery, whether the Mines, etc., Regulations would permit of them leaving the machine unattended.

Mr. STEWART (Bloemfontein) said such sets were in use in the country to-day.

The Convention at this stage considered a resolution which recommended that A/C be used for universal generation.

Mr. BELLAD-ELLIS (Queenstown) was afraid that if they adopted that they were going to commit some of the smaller municipalities and preclude them from ever having the benefit of electricity. He considered a motor convertor quite reliable, and a battery set too, but he said if they had to run that motor convertor or a battery, which would lose 35 per cent., and they had a 35 per cent. loss from the generator to the convertor, they had nothing more than 40% out of that combination.

At this stage a discussion ensued as to the status of the Convention to enforce any of their recommendations, and varying opinions were expressed as to the form resolutions should take. It was urged that the effect of the discussion would be lost unless some definite recommendations were adopted in regard to the paper and passed on to the Standards Committee.

At the lunch interval Mr. Roberts's paper was still under discussion, and on the motion of Mr. Swingler (Capetown), it was resolved to continue the discussion during the afternoon, which had previously been set aside for visits to Municipal institutions.

Upon the resumption of business, the President read a report of the British Standards Committee on Standards, the following being the recommendations of that Sub-Committee, which was approved by the Sectional and Main Committees:—

(a) For continuous current measured at the consumer's terminal, 240 volts with 480 volts across the outer conductors of a three-wire system.

(b) For alternating current on the three-phase system measured at the consumer's terminals, 415 volts between phases, and for a four-wire system 240 volts between the neutral wire and each of the principal conductors.

Colonel DOBSON strongly supported the adoption of the pressures recommended by the British Standards Committee, and remarked that it was quite obvious that the pressures the Standards Committee had recommended were on the lines of future development and should be followed by those who could modify their systems so as to take advantage of anything in the way of standardisation. The figures approved by the Standards Committee should be agreed upon by them.

Mr. WOLLEY-DOD (Pretoria) and Mr. SANKEY (Port Elizabeth) contributed to the discussion, while Mr. STEWART (Bloemfontein) deprecated arriving at a decision on the subject in a single afternoon in a matter which required more serious deliberation.

Mr. du PASQUIER (visitor) thought it would materially assist their deliberations, and the Standarisation Committee too, if some definite recommendation were to be given from that Convention.

Colonel DOBSON (Johannesburg) expressed the view that all the existing systems would have to continue for some considerable time, and he took it that the object of the British Standards Committee was to mark an epoch in the history of electrical engineering.

Other points in the President's paper were discussed, and the following is a summary of the resolutions adopted in the course of the same:—

STANDARDS AGREED.

1.	Current	Alternating.
2.	Periodicity	50 cycles per second.
3.	Number of Phases	Three.
4.	Generating Pressures	415, 3,300 and 6,600.
†*5.	Supply Pressures	240 and 480 three-wire, 240 and 415 A/C four-wire.
6.	System of Distribution	4 wire 3 phase.
7.	Transmission Pressures	3,300, 6,600 and 11,000 volts.

†*In connection with this resolution a division was requested, the voting being as follows:—

For (7): Messrs. Sankey, Wolley-Dod, Millar, Jagger, Blatchford, Dobson and McDonough.

Against (5): Messrs. Roberts, Stoker, Stewart, Swingler and Bellad-Ellis.

BARE CONDUCTORS FOR OVERHEAD WIRES—

Nos. 12, 10, 8, 6 s.w.g. and beyond these sizes, the same sizes laid down by the British Engineering Standards Committee, but with the deletion of the following sizes:—

.125, .25, .35, leaving .05, .075, .1, .15, .2, .3, .4, and .5 square inch.

UNDERGROUND MAINS—

On the types of cables, it was decided to recommend that the system of protection adopted be uniform, viz., that the cables should be armoured suitable for laying direct in the ground, the sizes of conductors to be similar to those recommended by the British Engineering Standards Committee, with the deletion of the same sizes referred to in the bare conductors for overhead mains, leaving the sizes for adoption as follows:—

.05, .075, .1, .15, .2, .3, .4, and .5 square inch.

† since the Convention a Minority Report has been issued, subscribed to by 18 members of the Association out of a total of 32, who do not favour 240 volts, being of opinion that a lower pressure (say 210 or 220 volts) should be adopted. This Report, together with the Resolution, has been forwarded to the S.A. Engineering Standards Committee.

It was also resolved to recommend that as it was desirable that the various kinds of mains in use should be readily distinguishable from the outside without cutting the cable, that makers be asked for suggestions in regard to this matter, such as by varying the width of the standard tapes, or by introducing a steel wire or wires in the jute serving, commonly used over the armouring.

METERS—

That two two-wire meters be adopted for use on low tension supplies in preference to three-wire meters.

SIZES—

3, 5, 10, 25, 50 and 100 amperes.

PLUGS FOR HEATING AND OTHER CIRCUITS—

This matter was referred to the Council to decide upon certain standards as regards sizes, dimensions, etc.

On the proposition of Colonel Dobson, Mr. C. J. Everett (Johannesburg) was elected a member of the Association.

On the proposition of Colonel Dobson, it was resolved to hold a meeting of the Council at 9.15 the following morning to consider Standardisation and Wiring Rules.

"THE CONVENTION" AT DINNER.

On Thursday evening the members and delegates attending the Convention were the guests of the Engineering Section of the Natal Society for the Advancement of Science and Art, who were giving their first annual dinner. Mr. J. E. Borain (chairman of the section) presided over the gathering, and was supported by Mr. John Roberts (President of the Convention), Mr. B. Sankey (Vice-President of the Convention), Colonel Dobson, D.S.O., the Deputy-Mayor and others. About a hundred gentlemen sat down to the repast, and amongst those present were Mr. G. A. Payne (chairman of the Electrical Committee of the Durban Corporation), Dr. Campbell, Lieut.-Colonel J. W. Carr, and Captain Phillamore, D.S.O.

The function was a very bright and enjoyable one, and was a distinct success. Several entertaining after-dinner speeches were delivered, but pressure upon space precludes a detailed reference. The toast-list, after the Royal toasts had been honoured, was as follows:—"Our Guests," Mr. Borain, replied to by Colonel Dobson; "Durban Corporation," Dr. Campbell, replied to by the Deputy-Mayor (Councillor Jameson); "Engineering Section," Mr. Wolley-Dod, replied to by Mr. John Roberts; "The Army and Navy," Mr. Malcolm, replied to by Captain Phillamore and Lieut.-Colonel Carr.

The menu was an amusing souvenir, as it had been printed according to the correct engineering terms, and was set out as a "detailed specification." On the whole, both hosts and guests enjoyed themselves thoroughly, and a most successful evening was passed.

SPECIFICATION

OF

ONE (ONLY) SOLID DINNER

UNDERTAKEN TO BE DELIVERED TO

The Association of Municipal Electrical Engineers (S.A.)

AT THEIR SECOND CONVENTION

BY THE

ENGINEERING SECTION

OF THE

Natal Society for the Advancement of Science and Art

AT THE ROYAL HOTEL, DURBAN,

ON THURSDAY, 30TH AUGUST, 1917, AT 8 P.M.

NOTE.—If the plant specified herein is not taken when offered at the time and place mentioned, the contract will be cancelled.

TOASTS.

"The King" - -	The Chairman	- - - - -
"Our Guests" -	The Chairman	Reply, Col. Dobson, D.S.O.
"Durban Corporation,"	Dr. Campbell	Reply, Deputy Mayor.
"Engineering Section"	Mr. Wolley-Dod	Reply, Mr John Roberts.

This function is the first annual dinner of the Engineering Section of the Natal Society for the Advancement of Science and Art.

Chairman: Mr. J. E. BORAIN. Vice-Chairman: Mr. JOHN ROBERTS

Committee:

Mr. J. H. NEAL.	Mr. H. B. GEMMELL.	Mr. A. F. BEARPARK.
Mr. W. B. GRAY.	Mr. C. BATEMAN.	Mr. J. PULLAR.
Mr. W. McEVOY.	Mr. J. L. MALCOLM.	Mr. JOHN MURRAY.
Mr. I. VINCENT.	Mr. R. W. WATSON.	

Messrs. H. CLARK and W. D. KYLE, Hon. General Secretaries.

Mr. E. POOLE, Hon. Secretary Engineering Section.

The object of the Engineering Section is to promote the interests of Engineers in Natal and a closer relationship between Natal Engineers.

Meetings at which papers are read take place monthly, and the following is the programme to the end of 1917.—

Sept. 14th ... "Rainfall in connection with Engineering" ... ...
By Mr. H. B. WRIGHT.

Oct. 12th ... "Treatment of water for steam raising purposes" ...
By Mr. J. B. S. ARLIDGE.

Nov. 9th ... "Refrigeration" ... ... By Mr. C. COBBLEDICK.

DETAILED SPECIFICATION.

PRELIMINARY.

Receivers of the plant are entitled to receive ample supply of Lubrication.
No responsibility for the performance of the plant will be accepted unless the matter is reported.
Advice will be given gratis by the supplier's experts on the subject.

WAR CONDITIONS CLAUSE.

Owing to difficulties in obtaining supplies, items are subject to variation without notice.

Name of Item	—•• MAIN PLANT. ••—	Remarks.
Hors d'ouvres	To be of the usual English pattern, modified where necessary to suit South African :: :: :: conditions :: :: ::	
Fish.	Guaranteed 1917 model, supplied immersed in high-class insulating liquid of s.p.g. not :: :: :: less than ·9827764· :: :: ::	Light Lubrication to be commenced here.
Soup.	Receivers have the choice of two visiosities (measured by the well-known B.P. method.)	
Entree.	Asparagus (delivered at the absolute zero or thereabouts) of the automatic type, no tools being required for taking to pieces.	Lubrication should be forced if necessary here.
Joints.	Our own patent for insertion only. To be of the universal type, being equally suitable for the largest pipes or the smallest electric wires. (PowerStationsSuperintendents grow fat on it!)	
Poultry.	New S.A. Standard type. Material used is to be of low tensile strength, mounted on substantial frame; wings and legs provided in duplicate, but not interchangeable.* Supplied packed with S.A.G.E. composition. :: Blow down valve not included. :: (*Interchangeability is in course of development, and experiments are being conducted.)	
Sweets.	To be manufactured to the specification of two eminent sugar refinery engineers. Can also be supplied in High Pressure steel drums under the one registered name "Murmal," and labelled Dangerous in large red letters.	All Lubrication to be well charged here.
	—•• AUXILIARY PLANT. ••—	
Cheese.	To be of the low voltage type, but special high pressure type can be obtained on request (being normally kept in our own primary cells)	
Coffee.	Guaranteed non-sludging and good :: :: :: conductivity. :: :: ::	Fires may be set away.
Ices.	To be at a temperature below 700° F. :: ::	
Cigars.	Safety type, calorific value not less than 1,000 B.T.U.'s per ton, and guaranteed to :: burn freely under light induced draft. ::	

NOTE.—Judicious lubrication is recommended for some time after fires are started.

FRIDAY'S PROCEEDINGS.

MEMBERS PRESENT: The President (John Roberts), B. Sankey, A. S. Munro, A. Brittle, P. J. Gold, C. T. Wolley-Dod, Col. J. H. Dobson, C. J. Everett, T. Millar, T. Jagger, W. H. Blatchford, R. A. Stoker, G. A. Stewart, M. McDonough, G. H. Swingler, W. Bellad-Ellis, E. Poole, and P. Finlayson.

DELEGATES PRESENT: Councillors Smith-Hudson, C. J. Bischoff, J. Crawford, and E. Hopper.

In accordance with the resolution passed at Monday's meeting, the President called for nominations for Council. The following were then submitted:—

Cape Province:—W. Bellad-Ellis, moved by Mr. Brittle, seconded by Mr. Swingler.

Orange Free State:—G. A. Stewart, moved by Mr. Stoker, seconded by Mr. Millar.

Transvaal:—T. Wolley-Dod, moved by Mr. Everett, seconded by Col. Dobson.

Natal:—T. Jagger, moved by Mr. Poole, seconded by Mr. Munro.

Adopted.

Papers for Next Convention.

The following papers were promised for submission to next year's Convention:—

1. "Gas Plants": F. Castle (Oudtshoorn).

2. "The Local Manufacture of Goods from S.A. Products": C. J. Everett (Johannesburg).

3. "Draft Regulations for the Licensing and Registration of Contractors": C. H. Swingler (Capetown).

4. "Electric Cooking and Heating": B. Sankey (Port Elizabeth).

Sub-Committee re Draft Bye-Laws for Wiring, etc.

It was reported that the Sub-Committee appointed to deal with the question of drafting bye-laws, wiring rules, and form of contract in connection with the supply of electric current, had nominated Messrs. Stewart (Bloemfontein), Sankey (Port Elizabeth), and Wolley-Dod (Pretoria), to draw up the same.

Thanks.

On the motion of Mr. Bellad-Ellis, seconded by Mr. Sankey, votes of thanks were accorded the following, all of whom had entertained the Convention:—The Mayors of Town Councils of Durban and Pietermaritzburg, the local Engineering Society, Messrs. Lever Bros., directors of Mount Edgcombe Sugar Estates, Mr. J. Kirkland for his lecture on "Railway Electrification," Mr. du Pasquire for his contribution to the discussion on "Standards," all donors of motor-cars for conveying members attending Convention to places visited, officials at Durban and Pietermaritzburg Power Stations, and Mr. G. A. Payne (Chairman of the Durban Electricity Committee).

Printing of Proceedings.

The Convention gave its formal consent to expenditure being incurred for printing of proceedings.

The President read a letter of appreciation from Councillor Francis (Bethlehem), expressing the sense of usefulness the Convention had been to him.

Resolutions re Contributions to Relief of Rates.

In accordance with the intention expressed on Thursday, Councillor Hopper (Capetown) submitted resolutions to the Convention dealing with charges for current supplied to other municipal departments, the appropriation of net profits for the relief of rates, the necessity for making provision for obsolete plant, and reduced charges to consumers.

Mr. HOPPER argued that it was not right that the consumer, who had to pay an extortionate price in some cases for current, should be the victim for the amelioration of the person who did not pay for the current. The consumers should really have the benefit if it did not go to the Reserve Fund. A reduction in tariff would result in a larger demand.

Councillor SMITH-HUDSON (Port Elizabeth) seconded Councillor Hopper's proposals, and made a suggestion altering the wording of the resolution so that the word "profit" was made to read "net profit."

Mr. STEWART (Bloemfontein) agreed with the sentiment of the resolutions, but did not think them practicable.

Mr. SWINGLER (Capetown) said it would mean that most municipalities would get street lighting at cost price, which was not fair to the undertaking. Durban paid 4% on their capital outlay, was it intended that such a contribution should be eliminated?

The PRESIDENT described that contribution as legalised robbery, and said their gospel was cheap electricity. Durban to-day had a loan debt of £400,000 on its undertaking, but had they kept within their own concern, the amount that had gone to the relief of the rates, which amounted to practically £200,000, by the saving of interest on those charges and the saving of loan they had had to raise, the position of the Department to-day would have been that the consumer would be getting current cheaper and the ratepayers would have had an enterprise practically free from debt. Contributions to the rates were a case of money easy come, easy go.

After further discussion, the following resolutions were adopted:—

1. That all charges arising between different departments of a Municipality should be based on Standard Tariff Charges where such exist, and in the absence of such Standard Charges should be based on the net cost of services given or received.
2. That we are of opinion that it is unsound policy as militating against the successful financial operation of Municipally-owned electrical undertakings to allocate net surplus profits for the relief of rates or for Municipal Funds, or to make indirect charges so as to unfairly reduce net surplus profits.
3. That the rapid introduction of new and improved machinery for the production of electricity renders it imperative that every electricity undertaking shall set aside out of its net surplus profits an adequate amount to write off obsolete plant.
4. That the only legitimate outlets for net surplus profits are the building up of an ample obsolescence fund, and the reduction of charges to the consumer in order to encourage the use of electricity.

Moved by Councillor SMITH-HUDSON, seconded by Councillor HOPPER:—

"That the foregoing resolutions as adopted be sent to the Town Clerks of South African Municipalities owning electrical undertakings and a covering letter be sent to Engineers who may not have been present at the Convention."

Motion put and adopted.

DESIGN, OPERATION AND MANAGEMENT OF SMALL ELECTRICAL POWER STATIONS.

The following paper was circulated, and, in the absence of the author, Mr. E. J. Hamlin (Stellenbosch) was taken as read, a resolution being adopted that all questions arising upon the same should be forwarded to Mr. Hamlin to enable him to reply to the same in the printed proceedings:—

INTRODUCTORY.—If sufficient thought be given to the design, together with good construction and economic control, there is no reason why towns having a population exceeding 3,000 should not have their own successful electricity supply undertakings.

South Africa presents many problems, such as the difficulties of transport, shortage of water, scattered houses in towns, etc. All such points demand mature consideration before a scheme can be designed. Some schemes have been badly designed, and although they have been in operation some years they have not yet paid thir way; but on the other hand some schemes have paid their way in the first year of operation.

The author therefore thought that a paper on "The Design, Operation and Management of Small Electric Power Installations" would be acceptable and useful.

THE PROPOSITION.—Careful investigation must be made of the possible field of consumption. Some years ago the author assisted in the designing of a small scheme. The town had twice been canvassed with a view to ascertaining the number of possible consumers and the result was disappointing; the total number of lamps promised only amounted to 12 kilowatts, even if they were all burning at the same time. The author, however, canvassed the town during a two weeks' holiday, and then the total of lamps promised amounted to 60 kilowatts—exclusive of street lights. This scheme is now called upon to supply 90 to 100 kilowatts on Saturdays.

This point is mentioned in support of the statement that thorough investigation is necessary, as otherwise the Council, or the supplier, will find itself unable to cope with the demand.

It must also be remembered that plants are economical in first cost and in operation in proportion to the constancy of their load factors. With greatly varying loads machinery may be idle for a large part of the time. Load factors may be increased in many ways; for instance, in certain parts of South Africa the wine industry is the principal one. When "pressing" and "distilling" the works go on for 24 hours a day and seven days per week for a period of six to eight weeks. This period corresponds to that of the poorer load factor period; therefore, by contracts with distillers and cold-storage companies the author was able to keep his load factor constant or practically so throughout the year.

After full investigations have been made and the figures show that the installation is economically possible, the further growth of the community with its probable industries must be well considered.

Plants have been designed and installed without provision for future extension, and without sufficient stand-by plant.

The only way in which a plant can be run successfully is that consumers are assured of the continuity of supply. It is false economy to employ cheap labour; in small central station works it means failure, so that the consulting engineer must make provision in his estimates for good workmen. Recently, through investigation into a small scheme that averaged £350 per annum for repairs and renewals, caused by careless management resulting from the payment of a salary which would not induce good men to apply for the position, I found that by paying an extra £60 per annum in salaries the above figure could have been reduced to £30 per annum and a saving of £260 per annum effected, in addition to which extra consumers would have been secured if the continuity of supply had been guaranteed.

It will therefore be seen that the first cost, efficiency and economy of an installation depend primarily on the ability of the designer.

It may, and does occasionally, happen that schemes are prepared by contractors, but this method is rarely successful.

The problems involved in the design of a small electrcial scheme are those of first cost, of construction, equipment, operation and maintenance.

It is the ultimate aim of a designer to produce electricity at a minimum of cost. Of course, there are some cases where it is not always advisable to design your scheme from this standpoint only. Take, for instance, a town such as the one to which the author is Engineer. This town has more trees per mile, most probably, than any other town in South Africa, and although the overhead system was the cheapest in the first case, far cheaper to the consumer for his house connection, nevertheless the author is convinced that for aesthetic reasons it would have been advisable to have instituted an underground system. It would not have paid sufficiently well to have provided the large depreciation fund which it has to-day accumulated, but some of its old and beautiful trees would not have been maimed and made to look ugly. However, in some of the newer towns and under other conditions a minimum of cost is essential. To accomplish this end, experience is necessary.

It is not within the province of a designer to design or so specify that only one class of machine can be used; he should specify so as to provide for a selection of different makes, "each designed to perform its function in the most economical manner, and to have these machines properly combined to form one complete unit for the purpose of generating electricity on an economic basis."

Since the economic operation of the plant depends upon the original design, great care must be exercised in the selection of the machinery, etc.

In designing a plant, and in the selection and arrangement of the equipment, some originality must be exercised. No designer should simply copy another scheme; what may prove economical in one case may probably be the reverse in another. Steam, Suction-Gas, Diesel Engines, Semi-Diesel Engines, and Water Turbines must all be considered with the question of the prime mover, whilst in some cases it is possible to purchase electricity in bulk advantageously, consequently it is almost impossible to attempt to standardise, but it must not be forgotten that in the design of a single power station it is imperative that a system of standardisation must be adopted in order to minimise expenses in construction and operation.

DRAWINGS AND SPECIFICATIONS.—Duplicate sets of blue-prints should be obtained from the manufacturers; one set to be filed and the other set to be returned approved or with the changes indicated thereon.

Before submitting plans and specifications for the purpose of obtaining tenders, they should be complete in every respect: the object being to dispense with "extras" as possible. Some contractors look to the "extras" for profit, and, in order to safeguard the public interest, schedules must be added in which the contractor has to state the rates at which they were prepared to supply "extras."

REPORTS.—When a proposition has been well considered from both economic and engineering standpoints, it is necessary for the consulting engineer to report to the local Municipal Council.

It sometimes happens that the consulting engineer has difficult problems to solve: for instance, the author was engaged by a consulting engineer when the latter had to decide whether water or turbines or some other form of prime mover had to be used. It was found that by using the main-pipe supply of water to the town just before it entered into the service reservoir some 120-h.p. could be obtained for 12 hours per day, but the reservoir was situated some two miles from the town over rough country, subjected to heavy gales of wind, so the questions which had to be decided were:—

(a) Extra cost of feeders.

(b) The extra cost of battery to meet the conditions; a large battery to be used for periods of heavy load.

(c) The extra cost of maintenance.

(d) The saving in the cost of fuel.

(e) The saving in the cost of labour.

Before passing from this point, attention may be drawn to the great faith in water power that is possessed by people in this country. Frequently the author has been consulted regarding the possibility of utilising water power for the generation of electricity for small communities. Upon investigation, the supply is quite inadequate and too far away from the centre of distribution. People do not seem to realise that to transmit power to the town costs money, and the interest upon this money often more than covers the cost of fuel and maintenance for the different kinds of prime mover. Further, water which they desire to use for power purposes can often be more remunerative if used for irrigation purposes.

Naturally there are sometimes cases where by a little extra capital cost a Council may be able to construct a dam big enough for both water supply and generation of power, and provided there is sufficient demand for power, it might be economic to have a water plant.

There is another point which must not be overlooked, viz.: That the period of maximum rainfall in South Africa does not always occur in the winter time, when there is a maximum demand for current. Therefore, no definite rule can be laid down as regards storage, which will be applicable to the whole of South Africa.

BUILDINGS AND FOUNDATIONS: THE POWER STATION.—The initial cost of the power station depends upon many factors. Necessity requires only a building of durable construction and sufficient support to shelter and protect the machinery and those who operate it. An ornamental building will not increase the efficiency of the machinery, but it increases the final annual charges.

The ultimate aim in the design of an electrical plant is to generate electricity upon a commercial and economic basis. In towns of small communities the power station is usually located away from the main streets, so the architectural features of the building do not call for special consideration; but in the event of the power station being placed in or near the centre of the town, the architecture of the surrounding properties must be carefully considered and the building designed to harmonise therewith consistent with a due regard to economy.

To illustrate the foregoing, the author cites two examples from his practice. In one instance, attention was given solely to utilitarian objects, the station having been improved by surrounding it with gardens, rockeries, etc., and, in addition, each employee is allotted a piece of land to cultivate a vegetable garden—this has a decided effect upon the morale of the operating staff, whose efficiency is thereby increased. In the second instance, a power station was designed for erection in the centre of a town, and some attention had to be directed to its architectural features, but such consideration was not permitted to influence the principal object, viz.: efficinecy of working.

MATERIAL.—In the construction of buildings to contain electrical plant, it is essential that they shall be as fireproof as possible. This can be attained by using brick, concrete, or steel.

The situation of a town has a direct bearing on the nature of the material to be used. In South Africa the cost of the carriage of bricks to and scarcity of skilled labour in some towns, makes it imperative to build in concrete. One town can be instanced—Paarl—where it is cheaper to build in rough dressed granite than in brick.

WALLS.—The inside of a generating station should be as well lighted as possible. The author usually specifies an application of a smooth cement plaster surface, whitewashed from the roof down to about five feet above the floor, where it is met by a wainscoating of olive green formed by the application of three coats of good quality oil paint—which can be washed daily.

FLOORS.—Floors are usually of concrete, but present a better appearance if finished in a dark colour granolithic—which can be done by the introduction of iron oxide to the top dressing of cement plaster. A cleaner appearance is obtained by the use of granolithic, drips of oil being rendered inconspicuous.

ROOF TRUSSES.—There are many standard forms of roof trusses, and the engineer should so specify that a standard form may be used.

VENTILATION AND LIGHTING.—It is highly necessary to secure good ventilation and lighting. Arrangements should be made so that some of the artificial lighting may be obtained from a storage battery.

LAVATORIES.—Well-equipped lavatories are necessary. The baths and bowls should be of white enamel, which will induce a greater degree of cleanliness, as any dirt will be immediately visible. Lockers should be provided for the men.

Hot water for baths should always be available, so that the workmen, before going on duty, may have a change and clean up, whilst an outside workman oftentimes gets wet through working in rainy weather, and a hot bath tends to ward off colds and so prevents his efficiency being impaired. So apparently trifling matter as a bath is very often overlooked, but it has been the author's experience that the provision of the same has gained much time and maintained efficiency.

THE FUNCTIONS OF FOUNDATIONS, NATURE OF SOILS AND PILING.—The following gives a brief outline of the importance of foundations. Trial holes are usually put down, and the results obtained from these are plotted as a guide for the contractors. A clause is usually inserted in the specification which makes it essential for the contractor to examine the proposed site himself and check the results of the Consulting Engineer, and exonerate the latter from all blame.

The functions of a foundation are two in number:—

Firstly, a bed must be provided which will permanently maintain the machinery firm and level with all its parts in true alignment.

Secondly, it must be so constructed and proportioned that it will absorb shock and vibration as far as it is possible to do so. According to the class of machine and its location, one or other of these considerations will assume primary importance. Thus, with a purely rotary machine such as a steam turbine or electric motor, correct levelling and alignment are of greater importance than the absorbing of vibration which, in a well-balanced rotary engine, should be almost entirely absent. This means lighter foundations than those which would be required for reciprocating engine or machine, the unbalanced parts of which set up vibration that can only be effectively damped by a heavy bed and possibly some special means in addition. Location must be taken into account, because in certain situations even the smallest amount of vibration is prohibitive, whilst in others the only limit is that which the machine itself will stand without injury. Design, so far as it affects engine or machine foundations, is the duty of the engineer and comes within his scope except when conditions of soil are such that the whole area under the works requires special treatment.

PREPARATION OF SITE.—The author has, so far, dealt with certain specific soils, but it is a common experience to find a hard soil superimposed on a softer soil and vice versa, and in such cases sound judgment is required to secure the best results.

In the former case the upper stratum will often carry a considerable load safely, although the lower may be silt, or even quicksand. It is, therefore, not always desirable to pierce it as the overlying hard soil flats, as it were, on the softer one, the pressure on the latter being distributed over a very wide area. Where the position is reversed and the softer soil is on top, the course to be taken depends upon the depth, but generally it will be found cheapest to sink to firm ground.

As the quality of the soil is known, it is usually an easy matter for the firm who supplies the engines to design suitable foundations to meet the conditions. A reliable firm will not risk its fair name and reputation for the sake of a few cubic yards of concrete, whilst the consulting engineer is usually on the safe side in considering the suggestions advanced by the makers of the engines, even though the latter course may involve pile-driving, or, as in a case which the author had recently to decide, expensive drainage.

Foundations should always be made of concrete:—

1 : 2½ : 5 : for the smaller type, and
1 : 3 : 6 : for larger foundations.

The machines being usually duplicate sets, the only one set of forms are necessary for the foundations. The forms must not be removed until such time as the concrete has thoroughly set, otherwise the concrete will assume a different shape.

Templates must be constructed for locating the anchor blocks. The templates should be constructed of planking thoroughly braced with diagonal bracing, so as to prevent any warping and thus throwing out the true location of the anchor bolts.

GROUTING.—After the machinery has been properly set in position and anchored down, grout should be poured in to establish a final setting of the bedplate. An allowance of from one to two inches should be made in the foundations, and even in small foundations it should not be less than ¾ inch thick.

The grouting is a thin, rich mixture of cement mortar with little or no sand, specially prepared for the purpose of filling all spaces between the bed-plate and foundation and around the anchor bolts.

PRIME MOVERS.—The type of prime mover depends upon the locality and the size of the plant required. Water power is available in a few cases only, for reasons previously stated, and in South Africa seldom in sufficient quantities throughout the year if periods of drought occur, necessitating the installation of reserve oil or steam plants.

The choice of plant in many instances is limited chiefly to oil engines, suction gas plants, and steam plants, but it is impossible to say off-hand which type of prime mover is the best. The kind of plant to be adopted depends upon many conditions, so that careful study is needed in each case.

A suction-gas plant may be preferable in one place, and entirely unsuitable in another place, which may also be said in regard to oil engines and steam locomotives.

In the matter of capital costs there is little to choose; the author had before him tenders for a plant consisting of 60-h.p. sets, and the difference in the price for steam, suction-gas and Diesel engine were negligible. The slightly lower price of the suction-gas plant was more than outweighed by the increased cost of building, whilst the adoption of an oil engine dispensed with the cost of stoking. The principal costs are made up of wages, depreciation, interest and sinking fund. The cost of fuel hardly ever exceeds 12 per cent. The saving in fuel costs with one system may thus easily be counterbalanced by the wages paid to a single stoker.

In the case of the plant controlled by the author the water is fed direct from the mains, and owing to the clean state of the cooling water as it leaves the engine it is used in the washhouses, and the Council is in hopes of further utilising the water for native bathing places. Provision is made against a failure in the water supply by means of auxiliary pumps fitted to a tank containing 5,000 gallons of water.

The author has recently been retained in connection with two hydro-electric power schemes. In each case a civil engineer designed all the necessary dams, pipe-lines and accessory works. This branch of work requires great experience and should always be left to an engineer possessing the necessary qualifications, experience and knowledge of local conditions. Harmonious working between the civil and electrical engineer respectively is usually possible. In each of the above cases there is an abundant supply of water for the requisite power, and the water will, after passing through the turbines, flow into a service reservoir.

A brief summary of characteristics of each kind of prime mover may not be out of place here.

WATER TURBINES.—These are decided according to general arrangement and pressure into:—

(a) Low pressure turbines placed in an open flume and working as re-action turbines with suction pipes.

(b) Medium pressure turbines running in a closed casing and working as re-action turbines with suction pipe.

There are various types of turbines which are still in use, but the latest modern practice tends universally in one direction, viz.: to employ Francis turbines only for all low and medium pressure plants, and impulse wheel only for all high pressure plants.

SUCTION-GAS PLANTS.—Suction-gas is used extensively throughout South Africa, the fuel used being chiefly anthracite; in some cases charcoal. Best results will be obtained from anthracite which is imported, as the Colonial material is of a very inferior quality. South African material submitted by coal merchants to the author contained as much as 13.8 per cent. of ashes and 3.2 per cent. of sulphur. The residue of such stuff cannot be cleared without hammer and chisel, and the washing of the gas has to be far more elaborate than in the ordinary type of gas engine. As a result, Welsh or Scotch anthracite is mostly employed where charcoal is not available, but in many cases where near coal mines it may be economic to use South African coal.

With an increase in the altitude the power of a suction-gas plant decreases about 3 per cent. for every 1,000 feet rise.

OIL ENGINES.—Various types of oil engines may be installed. For very small outputs, the gasoline type is suitable, as they can be obtained in different sizes up to 25 kilowatts.

GASOLENE ENGINES.—Gasolene engines are of the four-cylinder, four-stroke vertical type, directly joined to the generator, as they run at high speeds. The whole arrangement has a neat appearance, takes up very little space, and the machine may be run by a partially skilled labourer. The speed from no load to full load varies only four per cent. The fuel used is commercial gasolene, but any grade of gasolene or natural or artificial illuminating gas may be used. The ignition is by means of a low tension magneto, coil and battery.

DIESEL ENGINES.—The Diesel engine is at present undoubtedly the most economical one on the market, as it has the highest thermal efficiency obtainable (over 35 per cent.). This fact is not to be under-rated for places for which freight is very high and in all places where towns lie away from the railway; and where charcoal or ordinary coal is not available, it appears to me that the Diesel engine is the only possible proposition in order to keep the freight costs at all reasonable. Moreover, the unrefined oils, which are cheaper than refined materials, may be used, and the engine has the advantage that it is always ready for work. Ordinary ignition is not required, as this takes place by compressed air, so that the heating of hot tubes or the firing of coal or charcoal is unnecessary. The generator of the suction gas plant is replaced by an oil tank, which may be stored outside, and the building is in consequence cheaper than for a gas plant of similar size.

SEMI-DIESEL ENGINES.—The more expensive Diesel engine may sometimes be replaced by a modified ordinary oil engine. The distinctive feature of this engine is that it will work without any ignition apparatus, such as a hot tube or magneto, once the engine has been started by heating the vaporiser cap-end to a dull red heat. The successive explosions and the heat of compression keep the vaporiser hot. Crude oils may also be used with the type of engine, although they cannot be as heavy as for the Diesel engine. The consumption of fuel is, of course, under the circumstances, much higher than in a Diesel engine, varying from 0.65 lb. per h.p.-hour at full load to 1.0 lb. at quarter load in a 60-h.p. engine. The differences in the prices of Diesel and oil engines is, however, not sufficiently great to warrant often the installing of an ordinary oil engine. Moreover, the time will soon come when it will be as easy to get persons to run Diesels as it is now to obtain people to look after oil or petrol engines

Where the choice is that of an internal combustion engine, the Diesel engine possesses many advantages, and where there is little difference in annual charges it should be advised.

Among its advantages are the following:—

1. Its inflexibility.

2. That whereas in the ordinary type of oil, or gas, an explosive matter is drawn into the cylinder, such is not the case with the Diesel engine and thus ALL PREMATURE IGNITION IS AVOIDED.

3. That, whereas in the ordinary type of oil or gas engine an explosion takes place in the cylinder, there is no explosion in the Diesel engine cylinder—gradual combustion taking place during the working stroke.

4. The use of the usually troublesome ignition apparatus is thus obviated in the Diesel engine.

They are usually very satisfactory in running, easy of control, extremely low in running and maintenance costs.

The good running qualities of the engine are due on the one hand to the absence of any explosion, regularity of fuel supply, and to uniformity of ignition and comparative absence of noise and vibration. These two latter render the engine particularly well suited for use in crowded districts.

In the case in which the author is interested, the power station is situated opposite to a University College Natural Science Laboratory, without any complaint having ever been received.

GENERATORS, ETC.—From the report given to the Municipal Council on the proposed scheme, the size of the generator can be ascertained.

Further, the system of distribution having been determined, the class of generator is then fixed upon.

As previously mentioned, the choice of system of distribution for small towns usually lies between:—

(a) Three-wire direct current.

(b) Three-phase alternating current.

The designer of installations does not usually design the generators. The latter have within the last few years become more or less standardised, and through the co-operation of mechanical and electrical engineers, together with the assistance of the British Engineering Standards Committees, there is little fault to be found with the designs of firms of good repute.

The author has found from experience—which is limited to four years—that it is advisable to have generators connected direct to Diesel and Semi-Diesel engines, but that much better results are obtained if the generators be chain-driven at from 3½ times the speed of the prime mover when gas engines are used.

BOOSTER.—When the designer has made up his mind about the size of the battery and the charging current required for the same, it is an easy matter to determine the size of the booster.

EXCITERS.—These are of standard size for any size of alternator. When the speed of the alternator is given and the designer knows the voltage required for the exciter, the makers usually have a standard size to suit the condition.

SPARES.—In small installations, especially in the Colonies, it is essential that spares be bought.

SECONDARY BATTERIES.—This is most probably the most important part of any small central power station, and it is therefore surprising to find how many engineers do not understand this branch.

By giving attention to the battery the engineer-in-charge has a never-failing friend.

MODERN SWITCHBOARD DESIGN.—The switchgear is now recognised as the most important adjunct of the generating plant, and the engineer gives considerable attention to obtaining that arrangement and design which will ensure the greatest possible safety and reliability in working. The development of modern transmission schemes and the ever-increasing distances that are being dealt with by the adoption of higher and higher pressures can by no means be considered to have reached the limit, nevertheless the main principles, which must be kept in view when planning modern switch plant, are now well defined. These principles may be briefly summarised as follows:—

1. The plant must be so constructed as to ensure the utmost reliability in working and immunity from danger for all persons engaged in switching operations, or whose duty it is to carry out repairs while the plant is running.
2. The whole of the switchgear should be easy of inspection and permit of extensions without difficulty.
3. Considerable weight should be given to the best possible utilisation of the available space.
4. The connections between the switchgear and generating plant should be as short and as accessible as possible.

CONTINUOUS-CURRENT PLANTS.—The switchgear for continuous-current plants is almost invariably mounted on a switchboard consisting of an iron framework on which are fixed a number of marble panels corresponding to the number of generating units and feeders. These panels carry the necessary apparatus and instruments.

THREE-PHASE PLANTS.—Owing to the far higher pressures which are in use for three-phase systems than when continuous-current is used, more stringent regulations are necessary with regard to such schemes, in order to safeguard human life and to ensure satisfactory operation.

CHOICE OF SYSTEM OF DISTRIBUTION.—It has been assumed that the areas which are to be supplied with current are mostly small and that low voltage systems are employed. Whatever system is decided upon, the consulting engineer should see that the total amount of the annual costs are a minimum. For small communities the cost of the equipment must be kept as low as possible; of course, only as far as it is feasible with regard to the total annual costs. The cheapest plant is not always the most economical one.

In order to keep the running costs down, it may be advisable to do the work of the day in one shift. This is often feasible at first as practically none, or little, current is required from morning till lighting-up time. It is then possible to run the station with a very small staff, but it means the installation of a secondary battery. This also settles the type of plant, which has to be of the direct current class, independently of such reasons as the greater efficiency of the distributing network, and of small motors, and the greater life of metal filament lamps on direct current. With a one-shift day, the battery will have to be fairly large in many cases, but such a battery provides considerable reserve plant in case of break-downs or during times when the load is largely above the average. This may occur in South Africa on Saturdays, when all the shop lights are switched on. For a one-shift day the generating plant has to be larger than the average load justifies. The total work, which is taken out of the battery from shut-off to restarting, plus the conversion losses, must be added to the consumption during the working period. Thus, if the output of a station during this time is 200 units, and for the remainder of the 24 hours 50 units, the generators must do about 280 to 300 units.

For very small towns the 220 volt two-wire system is suitable. As South African towns are somewhat straggling, the three-wire 40 volts between the outers system is usually superior. A very considerable amount of copper is saved. 220 volt tungsten lamps are now as satisfactory as 110 volt lamps, and they may be obtained down to 10-candle power.

Occasionally a case occurs where it would not be advantageous to instal a direct current system. One scheme recently designed by the author is such a one; the town being about seven miles in length, consequently the efficient transmission makes it imperative that the question of alternating current be considered. In this particular case there is water in abundance, but not at the centre of gravity of the scheme, making it most desirable to use alternating current on account of the length of the feeders. On such a system three shifts are necessary, but highly experienced workmen are not required to operate water turbine plants as in the case of other prime movers.

It may be safely said that the choice of distribution lies between the three-wire Direct Current System and the three-phase Alternating Current System.

OVERHEAD LINES AND NETWORK.—This system, although it does not offer the same prospect of reliability and freedom from accidental interruption as a suitably installed insulated cable, is not to be overlooked when considering a network for a small community.

In small towns traffic conditions are such that there is little or no interference suffered from the installation of an overhead network. However, the great advantage in the selection of this system is the cost of connection to the customer.

For instance, take a town like Stellenbosch, many of the small houses average 15s. per month for electric light consumption. This is because they are run as students' boarding-houses—there being 1,200 students in the town—and consequently there is usually a light burning in each room. Now, to wire such a house costs probably no more than £11 10s., but in many instances the house connections for the same house from an underground network, would probably be £8, whilst from an overhead network it would be £1 5s. The author knows from experience that at least in South Africa it does not usually pay to instal an underground cable network, but, as remarked previously, it may be better from the aesthetic standpoint.

One point to which the author would like to draw attention, which is the great mistake of crowding the Feeder Poles of an overhead system. If the street lights are governed by a time-switch it would be much better to take the power from the pole before the feeder pole. In some towns the feeder poles are so crowded that they are, in the author's opinion, quite dangerous.

In the design of the network, it ought not to be overlooked that half-watt lamps burn rather more than half-watt per M.S.C.P. Allowance should be made for this, as the indiscriminate use of this class of lamp, if the above point is forgotten, means bad distribution.

CONDUCTORS.—Hard drawn copper has been and is still used considerably for overhead transmission lines.

Aluminium has been used for some time in electrical industries to replace copper as conductors, and the results of same have been very varied. In some quarters aluminium is looked upon with disfavour on account of the unreliability of the result obtained. In practically all the cases which have been investigated, the fault has not been due to the metal, but to the manner in which it has been made, attempts having been made to treat the aluminium as if it were copper—treatment which aluminium most strongly resents. To-day aluminium is gradually taking its proper place for electrical work: its high conductivity, about 60 per cent. of that of copper, and extreme lightness, about one-third the weight of copper, renders its use for conductors an extremely attractive proposition. Many lines have been erected and are working satisfactorily. In fact, from a careful examination of results obtained, it is evident that if aluminum is properly used and erected, it will work quite as well as copper, in many instances, and occasionally it can be used where copper would be sure to fail by corrosion.

A few indications as to the details which are important to the life of an aluminium line, may not be out of place here:—

In the first place, aluminium should be used throughout the work. At no place should it come in contact with another metal unless specially protected from moisture. If, for some reason, technical or otherwise, another metal has to be used, the whole should be painted with a protective paint so as to exclude air and moisture, owing to the highly electro-positive character of aluminium.

In the second place, where pitch is distilled to obtain benzine and analine, the air becomes foul. Copper cannot resist such conditions for long, but aluminium is the best resisting metal known.

Thirdly, when jointing aluminium, it is advisable to use aluminium binding wire.

Fourthly, it must be remembered that the tensile strength of aluminium is only one-half that of copper.

Finally, the poles should be nearer together than they are when a copper conductor is used or spreads must be used to keep the lines apart.

GENERAL MAINTENANCE AND MANAGEMENT OF SMALL ELECTRIC POWER INSTALLATIONS.—The engineer who has control of a small electric power installation, must have certain qualifications. He must:—

(1) Be a good mechanic.

(2) Have a sound knowledge of the principles of electricity and its application.

(3) Have had a sound business training which will give him a good knowledge of methods and men.

These qualities may here be briefly touched upon:—

The engineer has many mechanical difficulties to encounter, for usually he is far away from a town, and so he must be able to quickly turn his hand "to make something from nothing" in case of breakdowns.

Soon after the scheme under control of the author was laid down, it was found that the crude oil would not flow sufficiently fast to the engine. This meant that the oil had to be heated. At first, this was done by means of a paraffin blow-lamp, but the cost was too great. The author then made arrangements for the cooling water to flow in the channel containing the oil feed pipes, and since then the oil has flowed too quickly. This has meant a saving of at least £20 per annum. In such ways difficulties are overcome.

A practical knowledge of electricity is essential, but a thorough theoretical training is also necessary. It enables the engineer to locate faults quickly because he can argue from effects to causes. Further, if he knows his records are up to date, he is usually able to locate a fault at once. This is important, because too much stress cannot be laid on the continuity of supply. An electrical knowledge also makes the engineer careful of his battery. The battery at the author's station delivers about 20,000 units per annum, and whilst the author was in Europe the efficiency of the battery dropped 12 per cent. This means about 2,400 units per annum—quite a saving.

However, the greatest quality, in the author's opinion, is a commercial training. It makes the engineer systematic. He is able to tell from day to day how his station is performing, and is able to detect at once whether there is any leakage.

Further, he will arrange his work so that everything will work smoothly. For instance, the case of overhead transmission lines, these should be examined at least three times per week. This may appear to be waste of time, but it is not; in fact it means a saving of time eventually if the linesman does his work thoroughly. In many towns in South Africa the streets are lined with oak trees or Jarrah wood trees. The latter grow quickly, and unless carefully watched, will bring the outers together and thereby cause a short. Not alone is time saved, but a system is established in this manner.

Again, a business training trains the engineer to treat his customers respectfully. Many schemes are wrecked because engineers have not tact in dealing with their customers. The latter are often a nuisance, but it is the engineer's duty to listen to their complaints and to be able to answer them satisfactorily and quickly. The author found it necessary to get a book to contain all the information respecting consumers' accounts, which is brought up to date every evening. In this book the readings of the meters, the amount of the account, the date paid, the receipt number and cash book folio are given.

Further, the author got out a special book for the cashier.

With this special bookkeeping, all accounts can be treated as cash accounts. According to the regulations, a surcharge is made if the accounts are not paid by the 15th of the month. Should a customer forget to remit, a telephonic reminder is given—this the customer appreciates.

An apprentice is able to take the 350 readings on the last day of the month, and on the first of the month the accounts can easily be finished. The reading of the meter is given, together with the previous month's reading, and thereby the account is checked. The engineer has usually to keep his own ledger, because it is very difficult for an ordinary clerk in a small town office to be able to differentiate between capital and current expenditure.

TRAINING APPRENTICES.—It should be the endeavour of all Municipal Engineers to train a limited number of apprentices. By so doing, he benefits the nation, the individual, and the Council by whom he is employed. The author has three apprentices, and although they are sometimes a trouble, but the joy of seeing them develop greatly compensates for the trouble.

During their apprenticeship period, the time is spent as follows:—

First Year—generally assist in outside maintenance, making house connections, etc.

Second Year—power station work, switchboard, repairs, lathe work, etc.

Third Year—control of one feeder district and four hours per day in charge of station.

In addition, each apprentice is enrolled as a student of the I.C.S. electrical engineering course, and is given one and a half hours a day to do the necessary home-work. This is done in the author's office, and the author is able to assist the apprentices on any doubtful points.

In the above ways the boys become keen, useful and very economic to the Council.

CONCLUSION.—The author intended to give the results of many central stations using different prime movers, but the paper by Mr. Poole does away with the necessity. However, the author will be pleased to answer any enquiries respecting any point which may be raised.

The paper on tariffs precludes the author from touching on this side of the subject, but the following regulations have just been promulgated for Stellenbosch, and this gives in a concrete form the tariff which the author thinks the best for a small town:—

The Council shall have the right to supply electricity for power and heating purposes at 3d. per unit without insisting on separate meters being installed under the following conditions:—

(a) For lighting a charge shall be made at the scheduled rate per unit on the average monthly current used by the consumer over a period of two years preceding the date of the agreement under this section, which agreement must be entered into in writing.

(b) For the balance of the current used during any month payment shall be made by the consumer at the rate of 3d. per unit, being the rate applicable for current supplied for heating and power purposes.

(c) The condition in regard to gross and nett charges provided for in the regulations shall apply.

(d) Should any customer, who was served by two meters prior to the promulgation of this regulation, desire to take advantage of the provisions of this section, the Council shall have the power to dispense with the use of one of the meters and refund to the consumer the amount paid by such consumer in respect of the connection of the extra meter so dispensed with.

The author also thought that it would have been possible to give diagrams of special arrangements used for switching in street lighting and for the determination of the voltage at the feeding points. Should any member be interested in this branch of the subject, the author would be pleased to supply a set of blue prints. This is an important point in the design of a network if it is to work successfully.

Further, should any member wish to have a copy of the set of books devised by the author, it would be a pleasure to the author to post them on

The scheme at Stellenbosch cost £10,000, and commenced to supply current in May, 1914. On June the 30th, 1917, the following amounts were invested:—

(a) Sinking Fund £625

(b) For Renewals (Depreciation) ... £1,400

These figures, the author feels, show that the scheme has been worked economically, this together with the fact that it has never been necessary to "shut down," makes it possible to say that the scheme has been a success.

The author had many misgivings when requested to contribute this paper, but if it results in useful discussion, he will consider himself very well repaid.

The Discussion.

Mr. BELLAD-ELLIS (Queenstown) expressed surprise at the number of meters Mr. Hamlin stated could be read in one day.

Mr. BRITTLE (Cradock) hoped it would be possible for the books to be reproduced.

Mr. JAGGER (Ladysmith): Mr. Hamlin's paper has, perhaps, more interest for the engineers of the smaller Municipalities than for engineers controlling large stations, or for small Municipalities intending to put down a generating plant for lighting and power, and for this reason alone the paper would have had an additional value if steam plant as a prime mover had been briefly touched upon. A short description of the most suitable arrangement for engine-room, boiler-house, the various auxiliary plants, such as feed-water pumps, economisers and feed-water heaters, condensers, etc., with their uses, could have been included in the paper with advantage. There are a number of useful hints in Mr. Hamlin's paper which are worth remembering. The suggestion to provide well-equipped laboratories, etc., is a good one, but the drawback is that men do not always appreciate these commodities at their full value for any length of time, and it usually happens that, after a few months, when the newness has worn off, they are not used, but abused. Touching on the examination of overhead lines, if this had to be done three times a week I am afraid the cost of distribution would soon mount up and make the price of current to the consumer in most municipalities rather more than it is at present. An occasional examination, say once or twice a month, is usually sufficient if it is done properly.

Reply by Author (Mr. E. J. Hamlin).

I am sorry that on account of my inability to attend through illness that the paper was not fully discussed. Mr. Bellad-Ellis, to whom my thanks are due, is rather sceptical about the number of readings done in a day, but I can only assure him that it is true. Systematic working means efficiency.

With regard to the request of Mr. Brittle for books and blue prints, these will be supplied. It is a pity that they could not be included in the paper, but the cost of printing diagrams is rather prohibitive at present.

I must thank Mr. Jagger for his kind comments. Speaking generally, steam plants are rarely economical for small plants. The building required is usually larger, it is necessary to keep a stoker, it is necessary to keep the reserve plant constantly warmed up so as to be able to start up quickly. Of course it may be argued that it does not require quite such as experienced drivers, but this does not really count, for it pays to keep an intelligent driver always. When "boiled down" it is an economic question purely and simply. The lavatories, etc., at Stellenbosch are not abused even after nearly three and a half years' running. In fact, I find the men are annoyed with any employee who leaves the place in an untidy state.

As regards the examination of the overhead wires, I would remind Mr. Jagger that it is done by apprentices, who receive very little wages. I have found that it is necessary to drive these youngsters to become systematic, a quality lacking in most South African youths—at least this has been my experience.

Exchange of Obsolete Stocks.

Mr. POOLE (Durban) said it had been brought to his notice quite accidentally that a certain Municipality was in need of some material which Durban possessed, and which was regarded by them as being obsolete stock. It had occurred to him that there might be other Municipalities similarly placed of having a surplus of obsolete material which yet might be useful to another place. He suggested that they endeavour to ascertain what they really had got in this connection.

Mr. BELLAD-ELLIS asked if the prices asked for material would be those obtaining before the war?

The PRESIDENT said if they circularised the Town Clerks asking them to furnish the Association with a schedule of obsolete stocks in their stores, and upon receipt of the information circulated it among other Municipalities, a very useful purpose would be served.

Mr. SANKEY (Port Elizabeth) thought they should not try to make profits out of the respective Municipalities.

Mr. SWINGLER (Capetown) thought even if they passed any resolution Councils would go to the best market in selling obsolete stocks.

The PRESIDENT remarked that any understanding come to would not apply to ordinary stocks, which were readily saleable, such as copper wires, etc., but only obsolete stocks.

Eventually it was resolved that the Town Clerks of the various Municipalities be invited by the Secretary to furnish a schedule of obsolete electrical stocks, with a view to such stocks being exchanged or bought where a demand existed, the price to be that existing before the war, such a condition, however, not to hold good in regard to surplus stocks which were readily saleable.

Appreciative Remarks.

Councillors Hopper, Crawford and Bischof delivered short addresses, in which they referred in high terms to the value of the Convention.

The PRESIDENT, in reply, remarked that the Convention had done a very useful amount of work, even if they had not in all cases arrived at any definite decision. He alluded to the presence of Councillors at their deliberations, and expressed the hope that as they went on their numbers would increase. He deeply esteemed the honour of presiding over their deliberations, and trusted that they would all meet next year at Port Elizabeth, until which time he bade them au revoir.

Visit to Natal Sugar Estates.

In the afternoon the party motored out to the Natal Sugar Estates at Mount Edgcombe, where, by the courtesy of Messrs. Campbell and staff, they were conducted round the works and the whole of the processes of sugar production was seen and described, and the visit proved a very interesting one.

The Association of Municipal Electrical Engineers (S.A.)

LIST OF MEMBERS AS AT AUGUST 31st, 1917.

Messrs. JOHN ROBERTS, Durban (President).
B SANKEY, Port Elizabeth (Vice-President).
Col. DOBSON, D.S.O., Johannesburg (Past-President).
W. BELLAD-ELLIS, Queenstown (member of Council).
G. A. STEWART, Bloemfontein (member of Council).
T. C. WOLLEY-DOD, Pretoria (member of Council).
T. JAGGER, Ladysmith (member of Council).
E. POOLE, Durban (Hon. Secretary and Treasurer).
M. McDONOUGH, Bethlehem.
G. H. SWINGLER, Capetown.
W. H. BLATCHFORD, Greytown.
T. MILLAR, Harrismith.
F. T. STOKES, Johannesburg.
E. TAYLOR, Aliwal North.
E. T. PRICE, Johannesburg.
C. J. EVERATT, Johannesburg.
A. S. MUNRO, Pietermaritzburg.
C. K. TURNER, Kimberley.
F. CASTLE, Oudtshoorn.
N. D. ROSS, Potchefstroom.
R. W. FLETCHER, Krugersdorp.
W. LEONARD, Standerton.
L. L. HORRELL, Pretoria.
P. FINLAYSON, Pietermaritzburg.
L. B. PROCTOR, Boksburg.
P. J. GOLD, Benoni.
J. VOWLES, Kingwilliamstown.
E. J. HAMLIN, Stellenbosch.
C. W. McCOMB, Springs.
H. BRITTLE, Cradock.
R. A. STOKER, Kroonstad.
W. DOUGLAS, Ermelo.

NATAL SOCIETY FOR THE ADVANCEMENT OF SCIENCE AND ART

UNION OF SOUTH AFRICA

Municipal Electrical Undertakings

Paper Read before the Engineering Section at the Durban Technical College on Tuesday, 28th August, 1917,

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INTRODUCTORY

EARLY HISTORY — GENERAL — LEGAL — LACK OF UNIFORMITY—SOURCE OF POWER—COAL SUPPLY

(With Tables and Curves relating to the various undertakings.)

EARLY HISTORY.

A few years ago the municipally-owned electrical undertakings of what is now the Union of South Africa could easily be counted on one's hands, and from a list I compiled in 1904, there were then only seven, viz.: Bloemfontein, Cape Town, Durban, East London, Johannesburg, Ladysmith, and Pietermaritzburg, while there were six towns which were controlled by private companies, viz.: Claremont, Kimberley, King William's Town, Newcastle, Pretoria, and Potchefstroom.

Of the before-mentioned towns, Durban, East London, and Pietermaritzburg were supplying electric tramways as well as lighting, while Cape Town tramways was supplied by a private company, as were also Port Elizabeth and Camps Bay.

The early history of, from about twenty to twenty-five years ago, of South African electrical undertakings was mostly associated with private ventures as a start, Johannesburg taking the lead in that direction, and a brief sketch of a few of the early plants which were installed may well be included in this paper.

JOHANNESBURG.

The original installation was in the hands of the Johannesburg Lighting Company, and consisted of a small belt driven bipolar dynamo and horizontal engine, which was laid down as an experiment at the Gas Works, and additions were made from time to time as the load increased, and to meet the rapid increases in demand current was also purchased from the then Rand Central Electric Works at Brakpan. In 1905 the Dutch Town Council took over the combined gas and electric works at a cost of £165,000, which, with the British occupation, came under the present municipal control, who lost no time in establishing a new power station. A pressure producer gas engine plant was decided on, and it is probably still fresh in our memory of the unfortunate results which culminated in a law case and the abandoning of the whole plant in 1907, which was substituted by a steam plant, and at the present time it has grown to be the largest municipal plant in South Africa.

PIETERMARITZBURG.

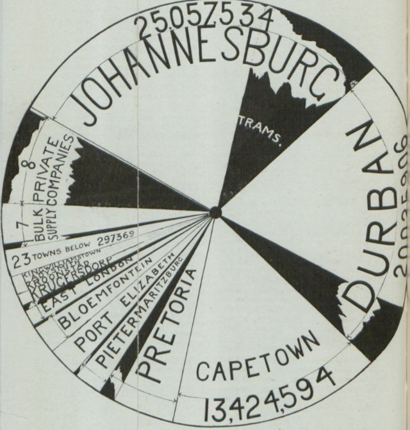
Supply was commenced here in 1895, when the Council took over the original plant installed by Messrs. Woodhouse & Rawson in the Town Hall, and consisted of a 36 K.W. rope driven 2,000 volt alternator. Some 4½ miles of H.T. overhead mains were then run with house transformers to supply a few consumers in the neighbourhood, and the success led to the present station being started in 1898.

DURBAN.

The earliest electric installation consisted of a small portable engine and dynamo, erected in 1886 in the Market Square for lighting the Town Hall close by. Some few years later a larger plant was put down by a private company, with no other rights than permission to supply in the centre of the town, until the Corporation erected their own plant, and this they did in 1897 at the Sewerage Outfall Works at the Point. This plant consisted of high speed vertical engines and alternators for the private lighting load, and Thompson Houston arc lighting machines for the street lighting, which was carried out by the open type of arc lamp.

As the load increased and it was decided to electrify the tramways, the present station at Alice Street was built, and a supply was given from here in 1902.

Though only a few years old, the plant at the Point works had by then become out of date, and was consequently superseded by plant of more efficient design, with which the new station was equipped, but at the present time very little remains of even this second instalment of plant, for with the rapid growth of the town and the universal demand for electricity, this plant has been superseded with plant of still greater efficiency in the form of turbines and marine type boilers of large capacity, and at no distant date another change will have to be made as the present site has very little space for future extensions.



SCALE DIAGRAM OF UNITS SOLD
IN THE
VARIOUS SOUTH AFRICAN TOWNS.

CAPE TOWN.

Any early history of Cape Town must refer to the suburbs also, seeing that Cape Town has absorbed most of the suburban municipalities, and it was the suburb of Rondebosch that first made a start with the supply of electricity.

The plant consisted of a D.C. dynamo of 44 K.W. belt driven from a steam engine, the system of distribution being 3-wire, 220 volts across the outer, and the price was 1/9 per unit.

This concession was acquired by the Cape Town and Suburban Syndicate in 1893, who installed A.C. plant at Rondebosch and removed the D.C. plant to Wynberg. In 1900 the Cape Peninsula Lighting Co. took over affairs, and in 1903 had installed turbine plant at Claremont, which enabled them to shut down Rondebosch and Wynberg.

Cape Town proper did not commence a public supply until 1895, when a small water turbine plant was installed at the Molteno Reservoir, with an accumulator station at Dorp Street. The system adopted was the D.C., L.T. 5-wire, with 110 volts between adjacent wires and 440 volts across the outers for motors, this being changed to 3-wire 220/440 volts in 1897. In 1898 Dorp Street was converted into a generating station, and was gradually added to until 1904, when a change was made to the present power station in Dock Road.

All the municipalities of the Cape Peninsula are now included in the Unified City of Cape Town with the exception of Wynberg, which, however, takes a semi-bulk supply from Cape Town. Kalk Bay plant, though not yet closed down, is considered as a sub-station, and when the additional plant has been installed at Dock Road, the whole of the generation will be from the one source.

GENERAL.

It is pleasing to note that to-day there are no less than 35 municipalities within the Union operating electrical undertakings, representing a total capital expenditure of about £5,500,000, including expenditure on tramways, with which Durban, East London, Johannesburg, Bloemfontein, Pretoria and Pietermaritzburg are provided, as well as electric light.

There are seven other municipalities who purchase their current in bulk from company undertakings, and generally carry out their own distribution work, a capital expenditure of about £170,000 having been incurred, including the expenditure in connection with the Boksburg and Germiston tramways. There are also four other municipalities who have granted concessions to companies who control the whole of the electric light undertakings, the capital expenditure on which amounts to about £28,000. Other concessions are at Cape Town, Camps Bay, Port Elizabeth and Kimberley, where there are privately owned electric tramways.

The grand total of units sold last year in all the various undertakings amount to approximately 84,500,000, and by a glance at the diagram it will be seen what proportion of the total units the various towns have turned out and also how the units are classified.

It will be seen that Johannesburg with over 25 million units, and Durban with over 20 million units, sell between them slightly more than all the other towns put together, Johannesburg's increase over Durban being practically all taken up in extra tramway units.

Unlike England, electric lighting has practically the monopoly, there being no gas works other than in Johannesburg, Port Elizabeth, Cape Town and Grahamstown, the former town being the only town having both gas and electric municipal works, and the latter the only town with a gas company holding the monopoly.

The subject I have chosen is one that opens up a very broad field, and I must limit this paper to a general tabulation only of those municipalities purchasing current and those who have granted concessions to private companies, and confine my remarks to those who control the whole of their undertakings, and even then I must be brief on the many details and not weary you as one might easily do on such subjects as distribution, tariffs, meters, etc.

I have classed the various undertakings in alphabetical order, and from the list it will be seen that Johannesburg has the largest output, having sold last year no less than 25,057,534 units, while Ceres has the smallest output with—but because it is small it need not be despised—an estimated sale of 9,000 units. To my mind it is the smaller towns we should encourage; in fact there are only small towns left now, and their problems need just as much consideration in proportion as do the larger towns.

There are few cases even in the small plants where current is not available during the whole of the 24 hours, for by having generally adopted direct current, a battery is added to meet with small demands when the plant is shut down.

LEGAL.

There are no Board of Trade Rules in South Africa as in England, though these regulations are in the main observed, but the various Provinces of the Union have certain Acts which the electrical undertakings are subject to.

In Cape Colony, Ordinance 6 of 1911 was the original Act in force, by which all tariffs and conditions of supply were subject to the approval of the Administrator. This Ordinance was subsequently amended by Ordinance 17 of 1916, which also provided for a supply outside any local area.

In the Transvaal, Ordinance 9 of 1912 empowered municipalities to establish and supply electricity both within and without their respective areas.

In the Orange Free State, Ordinance 4 of 1913 provides for electricity supply to the inhabitants of municipalities.

In Natal, Law 22 of 1891 is the "General Lighting Law," though the powers under this law are narrow and restricted, but the fullest possible provision has been made in the draft Local Government Consolidated Ordinance for the supply of electricity, both within and without the various municipalities.

There are two further Acts for the whole of the Union, one being the Post Office Administration Act 10 of 1911, which provides that persons establishing electricity works shall conform to certain regulations of the Postmaster-General. The other Act is the Mines, Works and Machinery Regulations Act 12 of 1911, which was passed to consolidate and amend the laws in force in the Union, certain previous laws in the several Provinces being repealed which were inconsistent with the provisions of the new Act.

LACK OF UNIFORMITY.

It is unfortunate that our electrical undertakings have no uniformity of plant, for we find all sorts of boiler pressures, engine and generator speeds, as well as voltages and frequencies, etc.

Also in statistical returns we have no standard for such compilation. Some towns go very fully into these returns in their Mayor's Minutes, whilst others are very brief.

In accounts we find all sorts of styles, so much so that it is almost an impossibility to make comparisons between one town and another.

It is to be hoped that some day this will be rectified to some extent at any rate, and we might look to the recently formed South African Municipal Electrical Association to take the matter in hand, in conjunction with the South African Standards Committee, which has just started seriously to work.

If uniformity had been aimed at more in regard to plant, the advantages would be manifold, for situated as we are here some thousands of miles from the manufacturers, if a breakdown happens, we may find ourselves without the necessary spares, or if we are short of the ordinary run of material we have to wait a long time for it, and it is little use expecting our local suppliers to keep spares or even hold stocks of all the varieties of plant in use, seeing there are so

Union of S.A. Municipal Electrical Undertakings, 1916.
Complete Plants, Light and Power.

GENERAL TABLE.

TOWN.	Population. W=White. C=Coloured.	Date of Start	Manager.	Source of Power.	Generation System. V=Volts C=Cycles P=Phase	Distribution system. O.H.M.=Overhead Mains V=Volts C=Cycles W=Wire U.G.M.=Underground Mains	Units Sold.	Max. Load K.W.	Plant Cap. K.W.	Year Load factor %	Capital Expenditure	Cost per K.W. Installed.	No. of Consumers Light.	No. of Consumers Power.	Street Lamps No.	Street Lamps C.P.	Remarks M.Y.B.=Municipal Year Book.
Aliwal North	W. 2,400 C. 5,060	1905	E. Taylor	Water and Oil	D.C. 500v.	U.G. mains only. D.C. 3w. 230/460v.	63,556	—	170	—	52,000	£ 306	226	5	87	50 100	Cap. Exp. includes whole cost of water scheme.
Bloemfontein	W. 13,800 C. 14,500	1900	G. A. Stewart (City Engineer.)	Steam con.	A.C. 2p. 2,100v. 50c.	D.C. 500v. U.G. & O.H.M. A.C. 200 and 347v. 3 and 4 W.	(to Mar. '17) 2,019,653	860	1,650	26.8	184,252	112	1,840		600	50 2,000	Trams also.
Bethlehem	W. 1,850 C. 1,350	1905	M. McDonough (Town Engineer.)	Gas	D.C. 500v.	D.C. 480/240v. 3 W. O.H.M.	———	—	125	—	—	—	130		—	—	Details from 1916 M.Y.B.
Cape Town and Suburbs	W. 85,156 C. 78,668	1895	(Acting) G. H. Swingler	Steam con.	D.C. 440v. A.C. 2p. 2,200v. 50c.	D.C. & A.C. various voltages. 2, 3, 4 & 5 W. U.G. & O.H.M. A.C. 2, 3, 4 and 5 W.	13,424,594	4,545	8,900	33.8	(1915) 655,000	74	7,586		2,500	50 to 1,500	Purchased from C.P. Co. in 1912. Supplying: Sea Point, Kalk Bay, Maitland, Woodstock, Mowbray, Claremont, & Rondebosch, also Wynburg (semi-bulk).
Cradock	W. 3,000 C. 3,400	1914	H. Brittle	Oil	D.C. 450v.	D.C. 220/440v. 3 W. O.H.M.	39,809	44	100	10.3	10,336	103	340	5	107	60 100	
Ceres	W. 946 C. 1,649	1910	P. S. C. Spies	Water	D.C. 145v.	D.C. 145 to 110v. 2 W. O.H.M.	(est.) 9,000	23	23	4.4	2,900	126	78	—	76	25	
Durban	W. 35,848 C. 38,312	1897	J. Roberts	Steam con.	D.C. 550v. A.C. 3p. 6,600v. 50c. A.C. 1p. 2,750v. 62c.	D.C. 550/500v. U.G. & O.H.M. A.C. 3p. 6,600 and 500v. A.C. 1p. 100, 200 & 400v. 2 & 3 W.	20,025,906	5,099	10,000	70 max 44.8	550,172	55	7,336	381	2,258 307 19 26	32 400 600 100	Trams also.
Ermelo	W. 2,400 C. 1,063	1914	A. Douglas	Steam nom con.	D.C. 500v.	D.C. 250/500v. 3 W. O.H.M.	47,846	—	50	—	8,711	174	180	3	64	100 200 400	
East London	W. 14,000 C. 7,000	1899	J. M. Lambe	Steam con.	D.C. 550v. A.C. 1p. 2,200v. 50c.	D.C. 500/550v. A.C. 110v. 2 W. U.G. & O.H.M.	1,474,736	1,010	933	29 max 16.7	56,318	60	1,711	89	571	—	Trams also.
Greytown	W. 1,210 C. 1,250	1904	W. H. Blatchford	Steam nom. con.	D.C. 220v.	D.C. 200v. 2 W. O.H.M.	55,660	44	74	25 max 14.4	6,538	88	192	6	85 3	50 400	Purchased from Collins & Kessler in 1904 for £2,050.
Heilbron	2,000	1904	———	Steam and Gas	D.C. 250v.	D.C. 230v. 2 W. O.H.M.	44,100	—	65	—	6,236	96	121		44	—	Details from 1916 M.Y.B.
Heidelburg	W. 1,527 C. 1,076	1915	T. H. A. Brown	Gas	D.C. 480v.	D.C. 440/220v. 3 W. O.H.M.	25,401	45	45	6.4	8,071	172	152	1	92	60 80	
Harrismith	W. 2,145 C. 3,352	1904	T. Miller	Steam	A.C. 1p. 2,000v. 50c.	A.C. 200v. 3 W. U.G.M. only.	115,628	60	185	22.0	21,000	113	312	6	162	100 50 32	
Johannesburg	W. 134,000 C. 119,274	1891	J. H. Dobson	Steam con.	D.C. 600v. A.C. 2p. 3,300v. 50c.	D.C. (inner area) 460/230v. 3 W. U.G. & O.H.M. A.C. (outer area) 400/200v. 1p.	25,057,534	11,043	13,750	25.9	1,101,254	80	16,091		6,681 1,300 278 33	50 100 16 1,000/2,000	Purchased from J.H.B. Light Co. in 1895 for £165,000. Trams also.
Krugersdorp and Randfontein	W. 13,114 C. 41,145	1908 1912	R. W. Fletcher	Steam con. non. con	D.C. 480v.	D.C. 230/460v. 3 W. O.H. & U.G.M.	752,878 82,802	500 50	700 120	17.2 18.3	43,476 10,351	62 86	1,111 177	59 6	322 75	60 60	Two Stations in Krugersdorp Municipality.
King William's-t'n	W. 5,571 C. 3,459	1903	J. Vowle	Steam con.	A.C. 1p. 2,200v. 50c.	A.C. 220v. 2 W. U.G. & O.H.M. 460v. Pumping	297,369	138	200	24.6	27,890	139	755	30	300	50	Purchased from King E. L. Co. in 1905 for £23,251
Kroonstad	W. 2,782 C. 3,071	1904	R. A. Stoker Town Engineer	Steam non. con.	D.C. 250v.	D.C. 230v. 2 W. U.G. & O.H.M.	516,376	153	180	63.5 max 38.5	12,500	69	411	17	143	50 100	
Klerksdorp	W. 2,203 C. 2,037	1911	J. R. English	Gas	D.C. 480v.	D.C. 230/460v. 3 W. O.H.M.	118,090	75	70	17.9	10,525	150	240	3	120	100	
Ladysmith	W. 2,283 C. 2,712	1903	T. Jagger	Steam non. con.	D.C. 220/440v.	D.C. 220/440v. 3 W. O.H.M.	360,567	156	475	26.4	23,097	48	356	9	212	60	
Newcastle	W. 1,300 C. 1,700	1902	G. N. Dawson ...	Steam non. con.	D.C. 250/500v.	D.C. 230/460v. 3 W. O.H.M.	59,169	—	156	—	8,677	55	230	2	app. 300	32 100	Purchased from Gellender & Co. in 1912 for £6,250.
Oudtshoorn	W. 5,849 C. 5,851	1911	F. Castle	Oil	D.C. 440v.	D.C. 220/440v. 3 W. U.G. & O.H.M.	133,602	135	305	11.3	41,000	134	523	14	286	50 100	Purchased from O.E.L. & P. Co. in 1911 for £33,000.
Port Elizabeth	W. 19,824 C. 13,232	1906	B. Sankey	Steam con.	D.C. 500v. A.C. 3p. 6,600v. 50c.	D.C. 250/500v. A.C. 1p. 250v. } 2 & 3 W. A.C. 3p. 6,600/500v. } U.G. & O.H.M.	2,065,706	930	3,500	25.4	197,198	56	2,432	164	10 flame 44½ watt 184½ watt 511 m.f.	Arcs 1,000 100-600 50	
Potchefstroom	W. 8,162 C. 4,955	1912	W. D. Ross	Steam con.	D.C. 250/500v.	D.C. 240/480v. 3 W. O.H.M.	137,611	125	120	12.6	20,000	166	440		130?	50 100	
P.M.Burg	W. 16,500 C. 16,000	1896	A. S. Munro	Steam con.	D.C. 550v. A.C. 3p. 2,300v. 60c. A.C. 1p. 2,100v. 100c.	D.C. 550/500v. A.C. 3p. 2,300v. A.C. 1p. 200v. 2 W. U.G. & O.H.M.	2,103,277	720	2,200	81.5 max 33.3	215,489	98	1,979	77	182 418	100-300 50	Trams also.
Pretoria	W. 29,440 C. 18,560	1892	T. C. Wolley-Dod	Steam con.	D.C. 550v.	D.C. 250/500v. 3 W. U.G. & O.H.M.	4,875,299	2,400	3,200	23.1	217,745	68	4,100	155	1,378 144 29	50 100 200-2,000	Purchased from P.E.L. Co. in 1904 for £115,000. Trams also.
Parijs	W. 2,000 C. 500	1913	W. McKenzie	Water	D.C. 460v.	D.C. 230/460v. 3 W. O.H.M.	33,911	—	30	—	5,500	183	170		60	100 60	
Paarl	W. 4,896 C. 6,124	1917	H. Wragg	Water	A.C. 3p. 3,300v. 50c.	A.C. 220/380v. 4 W. U.G. & O.H.M.	———	—	150	—	—	—	265 applications		250	50 400	Plant not completed.
Queenstown	W. 3,775 C. 5,326	1912	W. Bellod-Ellis	Oil	D.C. 460v.	D.C. 220/440v. 3 W. U.G. & O.H.M.	152,000	140	200	35 max 12.4	18,000	90	700	32	178 100	48 80	
Somerset East	W. 1,700 C. 3,314																
Senekal	1,700	1915	R. Rascher (Town Engineer.)	Gas	D.C. 500v.	D.C. 230/460v. 3 W. O.H.M.	(16 months) 28,480	30	45	10.8	5,426	120	96	4	43	50	
Stellenbosch	W. 2,700 C. 3,455	1914	E. J. Hamlin (Town Engineer)	Oil	D.C. 480v.	D.C. 220/440v. 3 W. U.G. & O.H.M.	78,648	82	80	10.9	11,564	144	328	21	167	50 100	
Uitenhage	W. 6,224 C. 5,349	1911		Oil	D.C. 440v.	D.C. 220/440v. 3 W. O.H.M.	———	—	270	—	30,259	112	180		296	—	Details from 1916 M.Y.B.
Winburg	W. 1,018 C. 1,540	———	W. H. Hodge	Gas	D.C. 240v.	D.C. 230v. 2 W. O.H.M.	32,937	25	36	15.0	4,081	113	131	1	88	32	
Wellington	W. 2,420 C. 2,578	1914	E. G. Mould (Acting)	Gas	D.C. 440v.	D.C. 220/440v. 3 W. O.H.M.	(generated) 98,000	—	96		11,268	117	258	6	120	60	
Worcester	W. 4,000 C. 4,500	1916	C. Duncan	Water and Oil	D.C. 440/500v.	D.C. 220/440v. 3 W. O.H.M.	61,919	54	127	11.0	14,065	110	251	32	240	60 100	

Union of S. A. Various Public Supply Electrical Undertakings, 1916.

Light and Power.

(Copyright)

MUNICIPAL BULK SUPPLY.

Town.	Population W. White C. Coloured	Date of Start.	Manager.	Bulk Supply from or Owners.	Distribution System. V. volts C. Cycles W. wire	Units Sold.	Plant or Sub-Sta. Capacity.	Capital Expenditure.	No. of Consumers. Light.	No. of Consumers. Power.	Street Lamps. No.	Street Lamps. C.P.	Revenue. Last year.	Tariff of Charges. L. Light P. Power	Purchase Price of Current.	Remarks.
Boksburg	W. 11,582 C. 32,077	1906	(Town Engineer). F R. Clark	Victoria Falls Co.	A.C. 230 volts 50 cycles 3 wire	546,000	400	24,826	1,000	20	600	50	8,991	6d Light 1½d. Power	1¼ pence	Trams Also.
Benoni	W. 15,000 C. 55,000	1912	P. J. Gold	Kleinfontein Co.	200 v. light 346 v. power A.C. 3 phase 25 cycles 4 wire	473,000	520	19,680	1,510	29	270	50	12,300	7d. to 4d. L. 2½d. P.	2½dlt 1½d pr	Motor Buses also. 80 Series Lamps 3,000 v. 6.6 amps for Lighting outside Lamps.
Germiston	W. 15,317 C. 38,244	—	—	Victoria Falls Co.	120 v. light 200 v. power A.C. 3 phase 50 cycles 3 wire	—	—	—	—	—	—	—	—	Power 1½d. Cooking. 5d. L 4d. P	—	Details from 1916 Municipal Year Book. Trams Also.
Kimberley	W. 18,000 C. 35,500	1904	R.W.H. Smith	De Beers Co.	A.C. 50c. 220 v. 2 & 3 wire	830,217	1,260	38,994	1,229	133	35 191	Incdts. Encd. Arcs	11.777	6d. less 1d. cash L 2½d P	2 pence	Supply Co. controls Distribution.
Roodeport	W. 7,192 C. 25,550	1912	R. Mortimer	Victoria Falls Co.	230 v. light 400 v. power A.C. 3 phase 50 c. 3 & 4 w.	225,984	225	14,015	750	4	248	50 watts	5,540	8d. to 6d. L 4½d. P	2¼ pence	
Standerton	W. 1,740 C. 1,559	1908	W. Leonand	S. A. Railways	D.C. 230 volts 2 wire	39,661	75	3,825	165	—	150	—	2,030	9d. less 10 % over 300 units	4¼ pence	
Springs	W. 2,000 C. 7,000	1912	(Town Engineer). C.M. McComb	Victoria Falls Co.	A.C. 200 volts 50 cycles 3 wire	82,677	200	5,500	242	6	114	Series Lamps	1,894	7d. L 4d. heating and cooking. 2d, to 4d. P.	1.63 pence	Portion of area 3 phase 3 wire.

PRIVATE COMPANY SUPPLY.

Town.	Population W. White C. Coloured	Date of Start.	Manager.	Bulk Supply from or Owners.	Distribution System. V. volts C. Cycles W. wire	Units Sold.	Plant or Sub-Sta. Capacity.	Capital Expenditure.	No. of Consumers. Light.	No. of Consumers. Power.	Street Lamps. No.	Street Lamps. C.P.	Revenue. Last year.	Tariff of Charges. L. Light P. Power	Remarks.
Dundee	W. 1,140 C. 1,852	1902	E.H. Gellender	E. H. Gellender and Co., Ltd.	D.C. 220 volts 2 wire (wiring 2 250 v. lamps in serier)	—	175	15,000	220	4	85	—	—	8, 4, 3 and 2 pence.	Steam Plant.
Indwe	W. 600 C. 500	1908	G. Muller	Indwe R'way. Collieries & Land Co.	D.C. 500 volts 2 wire	30,500	300	—	60	2	66	16	597	6d. L 2d. and 3d. P	In Liquidation Steam Plant was mainly used for Colliery.
Volksrust	W. 1,626 C. 891	1912	G. Strong	E. H. Gellender and Co., Ltd.	D.C. 220/440 volts 3 wire	—	100	8,500	150	—	126	—	—	11d. L 4d. and 3d. P	Steam Plant.
Vryheid	W. 1150 C. 1100	1908	B H. Sargent	I.R.G.P. Co., Ltd.	D.C. 200 volts 2 wire	21,560	27	3,500	140	1	60	—	1,078	1/- light and power.	Suction Gas Plant.

Tramways

MUNICIPAL SUPPLY

Town	Manager.	Date of start.	System.	Miles of Track. Single	Miles of Track. Double	No. and Type of Passenger Cars. S.D. Single deck. D.D. Double deck.	Other Rolling Stock.	Capital Expenditure	Units used.	Price per Unit.	Car Miles.	Passengers carried.	Total Revenue.	Operating Expenses for Car mile.	Remarks.
Bloemfontein	G. A. Stewart. (City Engineer).	1915	D.C. 550/500v. Trackless. span wire and bracket arm constn.	—	—	10 "R.E.T."	——	44,227	192,381	1d.	189,864	934,177	7.834	11.64d.	Year ending March, 1917.
Durban	H. N. Thomas.	1902	D.C. 550/500v. Trolley. centre, side and span construction.	9.25	11.15	90 d.d. 4 wheel. 1 d.d. 8 wheel.	3 Sprinklers, 12 Freight Cars, 1 Funeral.	591,714	3,701,851	1d.	1,726,[illegible]97	17,589,375	145,265	12.41	Purchased from Durban Tram Co. for £114,350.
East London	J. M: Lambe.	1899	D.C. 550/500v. Trolley. centre and span construction.	2	2	15	——	57,343	441,365	1-5d.	250,986	3,022,870	17,028	15.84	
Johannesburg	J. H. Dobson.	19[illegible]6	D.C. 550/600v. Trolley. centre side and span construction.	(Track.) 65.154		5 Motor Road Busses. 114 d.d. 4 wheel. 28 d.d. 8 wheel. 5 old Horse Trailers converted.	8 Freight, 5 Water. 2 Motor Tower Wagons (Elec. & Petrol).	880,456	7,855,151	1-379d.	3,377,014	(1915) 30,825,558	382,221	18.04	Purchased from Johannesburg Tram Co, in 1904.
P. Maritzburg	P. Finlayson.	1904	D.C. 500v. Trolley. centre and side construction.	6	2.25	1 Tilling-Stevens Bus. d.d. Brush Cars. 6 Bogie, 4 Radial, 6 Ordinary.	1 Water.	113,786	243,542	1-5d.	245,700	2,152,781	11,712	10.26	
Pretoria	T. Wolley-Dod	1910	D.C. 500v. Trolley. centre pole construction	3.67	6	3 Motor Busses. 25 s.d. 4 and 8 wheel.	3 Freight. 2 Water.	242,179	1,022,000	1-5d.	565,720	—	48,095	14.2	Purchased from Pretoria Tram Co. for £40,000.

MUNICIPAL BULK SUPPLY

Town	Manager.	Date of start.	System.	Miles of Track. Single	Miles of Track. Double	No. and Type of Passenger Cars.	Other Rolling Stock.	Capital Expenditure	Units used.	Price per Unit.	Car Miles.	Passengers carried.	Total Revenue.	Operating Expenses for Car mile.	Remarks.
Boxburg	F. R. Clark.	1914	D.C. 500v. Trackless. mostly span construction.	(Route). 5.25		6 "R.E.T." (28 passengers).	——	23,000	154,000	1-33d.	110,000	630,000	7,991	19.0	
Germiston	—	1914	D.C. 500v. Trackless. side pole construction	9.5		10 Cedes Stoll.	——	55,000	222,700	(av.) 1d.	192,707	—	7,329	13.[illegible]6	Details from 1916 Municipal Year Book.

PRIVATE COMPANY SUPPLY

Town	Manager.	Date of start.	System.	Miles of Track. Single	Miles of Track. Double	No. and Type of Passenger Cars.	Other Rolling Stock.	Capital Expenditure	Units used.	Price per Unit.	Car Miles.	Passengers carried.	Total Revenue.	Operating Expenses for Car mile.	Remarks.
Cape Town	W. F. Long.	1896	D.C. 550v. Trolley. span wire and side bracket const.	16.05	4.86	62 d.d. 15 s.d.	2 Freight, 3 Water, 1 Tower Wagon.	—	4,302,874	—	(Camps Bay Cars, 81,888) 1,993,393	18,434,842	172,168	11.98	Owned by City Tramway Co., Ltd. and Capetown and Green Point Tramway Co., Ltd.
Camps Bay	W. F. Long.	1901	D.C. 550v. Trolley. span wire and side bracket const.	6.87	—	7 open. 7 composite.	3 Freight,	Inclu. Power Station Plant 250,933	598,866	2-02d.	213,675	707,875	17,487	17.24	Owned by Camps Bay Tramway Co., Ltd.
Kimberley	—	1905	D.C. 550v Trolley. span wire and bracket const.	(Track.) 16		20 open type.	1 Freight, 1 Water.	—	—	—	311,229	2,089,863	—	—	From Municipal Year Book, 1916 Owned by De Beers Co.
Port Elizabeth	W. Freemantle	1897	D.C. 550v. Trolley. side bracket and span const	3.42	2.61	13 d.d. 21 s.d.	1 Trailer, 1 Water, 1 Prison Van.	175,000	1,046,410	1-208d.	550,000	4,042,524	40,600	11.23	Owned by Port Elizabeth Tramway Co., Ltd.

many different voltages, sizes, etc., required. On the other hand there can be very little interchange of plant between one municipality and other, even if one municipality were forfortunate enough to have plenty of spares.

SOURCE OF POWER.

The chief source of power is Steam, and since the greatly increased economics due to the introduction of the steam turbine and the recent improvements in boilers, steam is likely to be retained for some time to come.

Of Gas plants, the failure of the Johannesburg plant has no doubt caused a set back in the adoption of such large plants elsewhere in South Africa, but we find some successful small plants operating as at Bethlehem, Klerksdorp, Heilbron, etc., and no doubt by keeping to well established practice and using a good quality of coal there is a good future for such plants.

In Oil plants we find small installations at Queenstown, Oudtshoorn, Uitenhage, etc., where Diesel engines using crude oil are running with great success, and beyond the fact of having, so far, to depend on the oil from overseas, I see no reason why such examples cannot be followed elsewhere.

In Water power plants, Worcester and Aliwal North are partly dependent, and Cape Town has still a small supplementary water plant, but Ceres, Parijs and Paarl are the only towns entirely dependent on water.

Unfortunately water power in South Africa is generally out of court on account of its varying supply, for what are at one time raging torrents are merely small trickles at other times. We have all heard of the Victoria Falls Power Company, but I'm afraid as yet it is Victoria Falls by name only, and I can hardly see how a line can be constructed between there and say Johannesburg, to make it a paying proposition, seeing there is nothing of importance to pick up en route, and unfortunately we cannot shift the Gold Reef to the Falls. In Natal we have heard at times of the Howick Falls being harnessed, but a visit there in the dry season will soon convince one of its unsuitability except for a very limited supply of power, so that the Pietermaritzburg Municipality need not seriously consider taking a bulk supply from Howick.

COAL SUPPLY.

As coal plays such an important part in the production of electricity, a few remarks on our South African coal will be of interest. Coal is worked in all the Provinces of the Union, the largest producing area being the Middleburg district of the Transvaal, where it is of an average value of 12.673 B.T.U.

The other Transvaal producing areas are Boksburg, Springs and Heidelberg. In the Orange Free State we have the Vereeniging district, where the coal is lower in grade, being of an average value of 10.626 B.T.U.

In Cape Colony the seams worked are in the Molteno, Cyphergat and Serkstroom districts, but the coal is of poor quality. In Natal there are several districts where coal is worked, both north and south of the Biggarsberg, the average value south of the Berg being 13.079 B.T.U.

The finest South African coal, however, comes from the Hatting Spruit district, being as high as 14.306 B.T.U.

Outside the Union, in Rhodesia, we have the Wankie Colliery, where the grade of coal has a value of 13.039 B.T.U.

Dealing more directly with the details of the paper, I will sub-divide my remarks under the following headings, dealing with them in the order in which I have placed them: Generation, Distribution, and Financial.

GENERATION.

BOILERS.

In boiler plant we have two available types, viz., the water tube and the drum or fire tube, and since the latter is restricted in pressure and output it can only be adopted for small installations.

South African Municipal Electrical Undertakings.

PLANT.

Town.	Boilers: No.	Boilers: Types.	Boilers: Makers.	Boilers: Evap. Cap. From—To	Steam Pressure	Price Coal. (Short Ton)	G. gene'td lbs Coal Used Per Unit	Remarks.	Engines: No.	Engines: Types. R. reciprocating T. turbines S. steam	Engines: Makers.	Generators: Makers.	Generators: A. C. or D.C.	K. W. From	K. W. To	K. W. Total.	Remarks.
Aliwal North ...	...	...	...	...	...	...	...	... ...	2 1	Water Turbines Diesell Oil	Achilles ... Sulzer	I.E. Co. and Siemens	D.C.	45	80	170	Hart Battery; Balancer; Belt driven from Turbines
Bloemfontein ...	8	Lancashire ... Water Tube	Houldsworth B. & W.	6,500	165	11/11	5·8	Bennis and Chain Grate Stokers ...	4	S.R. Triple Ex.	B. & M. ...	E. C. C. and Crompton	A.C.	225	600	1,650	Ledward Evaporative Condenser and Cooling Pond; B.P. Motor Convertors.
Cradock ...	...	...	...	...	...	...	...	... ...	2	Diesell Oil ..	Sulzer ...	Witton ...	D.C.	...	50	100	
Capetown ...	7	Land & Marine	B. & W. ...	10,000—20,000	160	19/2	3·49	Tray Ash Conveyer; Chain Grate Stokers; Bucket Coal Conveyor	3 3 2	S.T. Impulse ... S.R. Triple Ex. S.R. Compound	B.T.H. ... B. & M. and Ferranti	B.T.H.... .. Siemens, M.&R. & E. Mfg. Co.	D.C. A.C.	300	3,000	1,700 7,200	Boosters for Feaders; Motor Converters; Balancer; 4 Surface Condensers; Chloride Battery.
Durban ...	2 4 3	Land water tube Marine Water tube	B. & W. ... B. & W. Hornsby	14,000—28,000	160	13/-	3·19(g)	Telpherage for ashes; B. & W. Bucket type Coal Conveyors; Chain Grate Stokers	5 1 3 1	S.T. Reaction S.R. Hor. Comp. S.R. Vertical S.R. Vertical	Parsons ... Y. & T. W. & R. and B. & M.	Parsons E. Mfg. Co. D.K. and E.C.C.	D.C. A.C.	200	2,000	2,750 8,750	Negative Boosters; Rotary Convertors; Barometric & Surface Condensers; Cooling Tower; Gear Turbine; Tudor Battery.
Ermelo	1	...	Garrett	2,000	200	8/-	7·5	.. ..	1	S R. Compound	Garrett ..	Witton ...	D.C.	...	50	50	Belt driven.
East London ...	4	Lancashire ...	...	...	160	18/11	5·99(g)	Gravity Bucket Coal Conveyor; Bennis Stokers	5	S.R. Compound	B. & M. ...	A.E.G. & D.K.	D.C. A.C.	125	200	375 575	Surface Condenser.
Greytown ...	3	Loco.	D. P.	1,000—2,000	100	12/6	...	Wattle Wood used also for fuel ...	3	S.R. Single Acting	McLellan ...	E.C.C.	D.C.	17	40	74	Tudor Battery.
Heidelberg ...	...	...	...	...	...	...	...	... ...	1	Suction Gas ...	Premier ...	A.E.G.... ...	D.C.	..	45	45	Belt driven; Static Balancer; Tudor Battery.
Harrismith ...	2	Water Tube ..	Rowland ...	3,000	150	10/2	12·8	... ...	3	S.R. Vertical...	Howden ...	M. & P. ...	A.C.	25	10	185	Condensers (seldom used).
Johannesburg ...	1 15	Dust Fuel ... Land & Marine	F.&C.Bettington B. & W.	14,000—35,000	175	approx. 10/-	3·59(g)	Tray Bucket and Ash Conveyors; Chain Grate Stokers	3 8	S.T. Impulse .. S.R. Vertical	B. & M. and Allen	Lahm. Siemens; D.K.; M. & P.; A.E.G. & L.D. & M. Co.	A.C. D.C.	250	3,000	3,750 10,000	Surface Condensers and Cooling Towers; Motor Convertors; Static Balancers.
Krugersdorp ...	3	Marine ...	B. & W. ...	6,000—7,500	160	14/-	6	Chain Grate Stokers	3	S R. Vertical...	B. & M. & Allen	B.P. & Siemens	D.C.	...	2,250	700	Balancers; Surface Condensers; Cooling Tower.
and Randfontein ...	2	Semi-Portable	B. & W. ...	...	150	15/-	16	... ...	2	S.R. Compound	B. & M. ...	B.P.	D.C.	...	30	120	Generators two in tandem; Battery.
K.W. Town ...	3	Economic ...	D. P.	5,000	150	23/6	7 (g)	... ...	3	S.R. Vertical...	B. & M. ...	E.C.C.	A.C.	50	100	200	Surface Condenser.
Kroonstad ...	3	Loco.	Rushton Proctor	40 H.P.	150	11/6	12·38	... ...	3	S.R. Vertical...	W. & R. ...	E.C.C.	D.C.	...	60	180	Motor Generator; P. & G. Battery.
Klerksdorp ...	...	...	...	...	...	...	...	... ...	2	Suction Gas ...	Hornsby ...	..	D.C.	...	35	70	Tudor Battery.
Ladysmith ...	4	Loco.	Robey & D.P.	1,400—2,475	145	8/3	11·19	... ...	4	S.R. Compound	W. & R. ...	E.C.C.	D.C.	50	110	475	Two Generators in tandem.
Newcastle ...	1	Loco. Return Tube	D. P. ... ... Hartman	6,000	120	3/-	...	... ...	1	S.R. Peache ...	D.P.	L. Scott ...	D.C.	...	78	156	Two Generators in tandem.
Oudtshoorn ...	...	...	...	...	...	...	...	... ...	3	Diesell Oil ...	Mirlees and Brit. West.	G.E.C. & Brit. West.	D.C.	90	125	305	Rotary and Static Balancers.
Port Elizabeth	4	Marine ...	B. & W. ...	8,000—15,000	200	15/9 to 22/9	4·62 4·11(g)	Bucket Coal Conveyors; Chain Grate Stokers; Ash Haulage	5 1	S.T Impulse ... S.R.	Parsons and B. & Lindley	D.K. & Brush & E C.C.	D.C. A.C.	200	1,000	1,400 2,250	Motor Convertor; Static Balancers; Surface Condensers & Cooling Pond.
Potchefst rom	3	Water Tube ...	B. & W. and Durr.	...	150	14/9	11·7 10·7(g)	... ...	2	S.R.	B. & M. ...	Siemens ...	D.C.	...	60	120	Condensers; Battery.
P.M. Burg ...	4 2	Water Tube ...	Hornsby and B. & W.	6,300—16,800	120	10/-	7·08 5·92(g)	Steam pressure to be raised to 160; Hodgkinsons & Chain Grate Stokers	1 8	S.T. Impulse ... S·R. Compound	British West. W. & R. and Peache	B.West.& B.T.H. Brush; E.C.C.	D.C. A.C.	120	480	840 360	Motor Generator and Rotary Convertor; Ejector and Surface Condensers and Cooling Pond.
Pretoria ...	6	Water Tube ...	B. & W. ...	...	160	10/6	6·0	Chain Grate Stokers; Bucket Conveyor	8	S.R. Triple and Compound	Allen; B. & M. & Chandler	B.P.; A.E.G.; E.C.C.; L.D. & M. Co.	D.C.	130	1,000	3,200	Surface Condenser.
Parijs ...	...	...	...	...	...	...	...	... ...	1	Water Turbine	Gilkes ...	A.E.G.... ...	D.C.	...	30	30	
Paarl	...	...	...	...	...	..	...	... ...	2	Peltons ..	Esher Wyss ...	E.C.C.	A.C.	...	75	150	
Queenstown ...	...	...	...	...	...	...	...	... ...	3	Diessel Oil ...	Mirlees ...	G.E.C.	D.C.	...	63	206	Tudor Battery; Balancer.
Somerset East	...	...	...	...	...	...	...	... ...	...	...	...	...	...	...	...	...	
Senekal ...	...	...	...	...	...	..	...	... ...	1	Suction Gas ...	Hornsby ...	E.C.C.	D.C.	...	45	45	Belt driven; P. & G. Battery.
Stellenbosch ...	...	...	...	...	...	...	...	... ...	2	Diessel Oil ...	Benz.	A.E.G.... ...	D.C.	..	40	80	Battery.
Winburg ...	...	...	...	..	...	...	...	... ...	1	Suction Gas ...	National ...	M. & R. ...	D.C.	...	36	36	Tudor Battery.
Wellington ...	...	...	...	...	...	...	...	... ...	2	Suction Gas ...	Hornsby ...	...	D.C.	...	48	96	Static and Rotary Balancer and Battery.
Worcester ...	...	...	...	...	...	...	...	... ...	2 1	Water Peltons Diessel Oil ...	Gilkes ... Petter	E.C.C.	D.C.	...	40	127	Static Balancer and Tudor Battery.

these have been superseded by a few large units doing the work of the many.

Speeds up to 3,000 revolutions per minute are now common in turbines driving alternators, but for direct coupled generators where a high speed is not advisable, a special form of gearing has lately been introduced with every success, which allows of a high speed turbine, and the first introduction of the geared turbine in South Africa is to be seen at the Durban Power Station, where the speed is geared down from 3,000 to 428 revolutions per minute. The saving in large turbines is very marked, and given a good supply of water for condensing purposes we are able to obtain a result as low as 14.3 lbs. of steam per unit as against 20 lbs. in a reciprocating set. In the smaller steam stations the reciprocating engine of the high speed vertical type still holds sway, and calls for little special attention, though there are still one or two instances of belt driven sets in the very small stations, while other stations have gas, oil and water, but as few towns are blessed with a water supply sufficient for power purposes, I need not make any further reference to them.

A tabulation, however, of the various types of prime movers may be of interest, and is taken from the Journal, I.E.E., May, 1909. The figures refer to Home costs costs for buildings and complete plant with a load factor of 52 per cent.:—

PRIME MOVER.	COST PER K.W. INSTALLED.	RUNNING COST PER UNIT.	LBS. FUEL PER UNIT.	OVERALL EFFICIENCY.
Reciprocating (con.)	£24·5	·422 pence	3·08	8·7
Gas	£23·5	·418 „	1·82	14·5
Oil	£23 to 25	·338 „	·06	27·8

In steam turbines there are two main types, of which we find examples in South Africa, viz., "Impulse," with its greater mechanical strength of construction and greater clearance, such as the Curtiss, Rateau, and Zoelly, with only a few stages of expansion; and the "Reaction" (the only example being at Durban), with its very small clearance, such as the Parsons, with about fifty or more stages of expansion; and at one time a combination of both had a certain vogue.

In the stations using reciprocating engines, we notice among others the Willans and Robinson, Bellis and Morcom and Allen high speed vertical type, both compound and triple expansion.

CONDENSERS.

In the smaller stations atmospheric exhaust is often adopted owing to the lack of a water supply, as well as the fact of keeping down the capital expenditure which would be incurred, and which a small plant would not warrant, though a saving of from 20 to 25 per cent. can be effected thereby with reciprocating engines. Of condensers we have many types, such as surface, jet, barometric and ejector, some with electrically driven circulating and air pumps, others with steam driven, and the fact of the vacuum gauge reaching to within .5in. of the barometer speaks well for the high efficiences now obtainable, which of course is also governed by ample cooling arrangements for the condensing water. The question of water supply for condensing purposes is one of great importance. Few towns have a natural supply, the general practice being to use water from the town mains, in conjunction with cooling arrangements, though Johannesburg is fortunate in having five bore holes from which a good supply of water is obtained.

Of the coastal towns, however, Cape Town and East London only have taken advantage of the sea water by building their power stations near the wharves; the other towns, when their plants were laid down, not perhaps appreciating the possibilities of such large outputs as now obtain, which makes the question of ample water supply of such great importance. Two methods are in use for limiting the amount of water required, either by the use of cooling towers, filled with brushwood and fitted with various devices for breaking up the water into as fine a spray as possible, and assisted with either forced or natural draught, and the other method is in the use of cooling ponds into which the water is generally sprayed.

OIL ENGINES.

I will confine my remarks to the Diesell oil engine, as being the type in use in this country, and is looked upon as the best of its class. Crude oil is used, and the principle on which it works is in the adoption of a high pressure at the beginning of the working stroke and the automatic ignition of the charge by the heat of compression. They are generally of the four-stroke type, in sizes up to 700 or 1,000 h.p., and vary in speed from 150 to 400 r.p.m., and above this power they are of the two-stroke single acting type. Like gas engines, they are, however, limited in overload to about 15 to 20 per cent.

GAS PLANTS.

In these plants we are probably more familiar with the engine than we are with the producer for making the gas, the engines being of the four and two cycle type, gas and air being admitted in the correct volume, compressed and then ignited by an electric spark just previous to the beginning of the impulse stroke. Two styles of plant are in use for the making of the gas, the first in the field being the pressure producer in which bituminous coal is used, and later on came the suction producer in which anthracite coal is generally used, and for small plants this principle is the more economical and less costly to instal. With suction plants using anthracite coal there is little trouble in cleaning the gas, but this is not the case in large pressure producer plants using bituminous coal, where the bye-products of chiefly tar and ammonia are looked on as a good source of revenue, and special provision has to be made for the recovery of same.

GENERATORS, Etc.

In generation we find examples of both direct and alternating current, the latter being three, two and single phase at various voltages and frequencies. In the larger towns we find —with only one exception—a mixture of D.C. as well as various phases of A.C. generation, but the smaller towns generally rely on the one source.

The exception in the larger towns is at Bloemfontein, where three-phase only is generated, and supplies the various sub-stations from where it is distributed, while rotary converters in the Power Station convert the three-phase A.C. into D.C. for the tramway supply.

At Durban generation is by D.C. for tramways and motor supply to private consumers, also single-phase as well as three-phase for lighting and power, the three-phase being used for Government bulk supply, large power consumers, the supply to the suburbs of Red Hill and Greenwood Park, and also for supplying rotary convertors used to supplement the D.C. supply. It is also transformed down to two-phase, 2,750 volts, through sets of special transformers (Scott connected), from which single-phase feeders are taken off and balanced between the two phases.

At Port Elizabeth generation is by D.C. and three-phase, the latter supplying motor convertors to supplement the D.C. supply and also for supplying the outlying districts with A.C. single-phase L.T. distribution, as well as three-phase for large power consumers.

At Pietermaritzburg generation is by three-phase as well as D.C. and single-phase, the three-phase supply being supplemented by a motor generator and rotary convertor from the A.C. single-phase and D.C. supply respectively.

At Johannesburg generation is chiefly from two-phase turbo alternators, with motor convertors for the D.C. supply for lighting and tramways in the inner area, but there are also a few reciprocating generator sets for both the A.C. and D.C. supply. The two-phase also supplies the outer area with single-phase distribution for lighting, and D.C. supply through rotary converters in sub-stations for tramways.

At Cape Town generation is by D.C. and A.C. two-phase, 2,200 volts, with motor convertors from the latter source of supply converting to 440 volts D.C. for the old Cape Town area. The two-phase supply is also transformed up through three banks of transformers (Scott connected) to 11,000 volts, three-phase for the suburban distribution and also for the supply to the Railway Works at Salt River.

In the smaller towns D.C. generation is practically universal. The exceptions are at Paarl, King William's Town, and Harrismith, the former town having made a wise and unique selection in A.C. three-phase at 3,300 volts, while the two latter towns have adopted A.C. single-phase.

The largest generators are in Johannesburg and Cape Town, being 3,000 K.W. each, and it may be of passing interest to mention that the smallest generator I have knowledge of was a 15 K.W. alternator which supplied the night private lighting load in Durban some twenty years ago. The ventilation of generators, particularly of the turbine type, in such a subtropical climate as this, is one of great importance by which heavier loads than otherwise are obtainable. Various arrangements are adopted for filtering and cooling the air, some generators being fitted with fans on the shaft, the air being drawn in through special filters. Another arrangement is by means of a water spray which cools the air, all the moisture being eliminated by the use of several baffle plates interposed in the spraying chamber, Cape Town having installed a "Heenan" wet air filter. Under this heading of generators, etc., I will briefly refer to other auxiliary plant installated, and taking boosters first, Durban is the only example where boosters are used to compensate for the voltage drop at distant points on the tram track to which points special mains are run, while Cape Town uses them for keeping up the pressure on the L.T. lighting network.

In regard to batteries, Durban and Capetown are the only large stations where a battery is installed, though in a few of the smaller stations batteries are installed with the object of being able to shut down the running plant during the hours of light load.

Balancers of the rotary or static type are to be found in several of the stations generating D.C. with three-wire distribution, by which the pressure drop on any one side, due to unequal loading, can be balanced.

In regard to the matter of "earthing" the generators, the universal practice is to "earth" the negative at the Power Station of a D.C. supply to tramways, and also to "earth" the neutral point in a three-wire supply. In A.C. single-phase working the side is always "earthed" to which the outers of the outgoing concentric feeders are connected, while in three-phase working with "star" wound generators, the neutral point is sometimes "earthed" through a small resistance, which in the case of Durban is 8 ohms.

SWITCHGEAR.

Many changes have taken place in the design of switchgear during the last 25 years, the old idea being a hand operated switch with a plain wire fuse melting in air. To-day, however, the design of switchgear has reached a high art, safety and reliability being the chief objects, and they are generally automatic in action. In the smaller stations operating at low pressure we sometimes even now find the old arrangement, but the magnetic blow-out circuit breaker is more often the type adopted for D.C. working. In A.C. stations the switchboard at one time, and even now in some stations, consisted of a number of panels spread out along a platform, each panel mounted with its switch, fuse, instruments, etc., and occupying a space many feet in length.

The latest type of switchgear as in use at the larger stations is the remote control, mechanically or electrically operated oil switch in cubicle form, with its assembly of instruments and small transformers, etc., and trip coils for operating the switch. They are fitted with various discriminating arrangements such as time limit devices, overload and reverse current relays, the controls being brought to any desired point and taking up very little space. In the smaller stations the switchboard is generally mounted on a platform a few feet off the engine-room floor level, where the electrician on duty has a clear view of the engine-room and the attendants to whom he can signal by hand.

In the larger stations, however, the switchboard is sometimes mounted on a gallery overlooking the engine-room, as at Cape Town, while at Pietermaritzburg there is a separate switch-room just off the engine-room, and at Johannesburg the switchgear is arranged on three floors, the lower floor for the entering cables, the middle floor for the actual switchgear and resistances, and the top floor, which is a gallery overlooking the engine-room, contains all the control mechanism for the switches, as well as the various instruments and signal controls. At Durban the switchgear is divided, that controlling the generators being mounted on a platform a few feet above the engine-room floor, while the outgoing feeders switchgear is in an adjacent room, where also is installed the boosters, convertors, three to two-phase transformers, etc. For signalling between the electrician on the board and the engineer, illuminated boards are to be found operated by a marine type controller. In addition to the generators and circuits, panels or cubicles, there are many accessories such as the synchronising panel, Board of Trade panel, power factor indicators, voltage regulators, recording instruments, etc.

In the case of Durban there is also installed a special time signal device which, by throwing a choking coil in the circuit at a time arranged (8 p.m.) lowers the voltage sufficiently for the consumers to observe, and thus their clocks can be adjusted, the time signal being given by the Post and Telegraph Department.

LOAD FACTOR.

Of factors, we find many forms in which they are expressed, but I will confine my brief remarks to the load factor as generally used and on which the economical working of the plant depends, and is expressed as follows:

$$\frac{\text{Units Sold}}{\text{Max. Load in K.W.} \times \text{Hours Run}} \times 100 = \%$$

From this we see that the higher we keep the units and the lower the maximum load the larger is the all important load factor, which is so much desired. The maximum load is one that can hardly be controlled unless the consumers are interested in it by arranging low tariffs to so induce them, as is done in many towns.

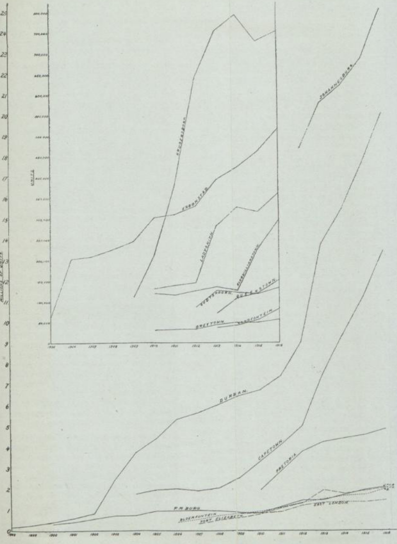
In the smaller stations supplying lighting only, one can hardly avoid the objectionable peak caused by the larger demand during the few hours when lighting is required in full, hence the low factor. In the larger stations, however, the introduction of motor load, cooking, tramways, electric vehicle charging, etc., has helped very much to flatten out the peak and thus improve the load factor, which is highest in Durban at 44.8 per cent.

From the slides will be seen examples of various kinds of load and the high factor effect of the total load, and the curve of units sold by some of the towns is of interest by showing the growth of the output.

In connection with load factor it may be of interest to refer to the matter of "daylight saving," and to observe in what way this will be affected, and though it will not affect a large mixed supply station as seriously as it will a purely lighting station, it is a point we may some day have to face.

We will take the case of the lighting load in summer time as the Durban curve shows, and this town will be affected more so than any other town in South Africa owing to its geographical position and the fact that approximately solar time is kept.

The peak load as well as the units for the day will be lowered, the evening units being chiefly affected, while the few extra morning units required will be of small amount.



CURVES SHOWING INCREASE IN UNITS SOLD.

With the curve shown, the load factor under ordinary conditions works out at 32.39 per cent., but with the introduction of daylight saving, it is raised slightly to 32.48 per cent., according to an imaginary curve which is interposed by way of example.

Apart from this influence on the plant, it also shows what saving can be obtained in the way of less coal consumption, which is the principal item in works cost, and seeing that such economy is of benefit to the nation as a whole, the electrical engineers can hardly protest at the measure on the grounds that a loss of revenue will result. In the case illustrated it will be found that 1,260 less units are sold during the 24 hours, and with a coal consumption of 3.25 lbs. per unit, it represents a saving of two tons for the day, while with an average revenue of 3.49 pence per unit it shows a loss of revenue of £18 for the day.

DISTRIBUTION.

GENERAL.

Generally speaking, the use of bare overhead mains is the common practice in South Africa. Some towns adopt it entirely; others have underground mains as well, but Harrismith and Aliwal North are the only towns where no overhead mains of any sort are used. There is no doubt the use of overhead mains has in a very great measure helped the progress of electricity supply in South Africa on account of the great saving in first cost, as well as the accessibility to carry out repairs. The prejudice of unsightliness and danger of falling wires is now practically non-existent.

The general practice in the case with feeders both for high and low tension mains is to lay them underground, but in a few cases extra high tension as well as high tension feeders are run overhead. With distributors the practice in the larger towns is to lay them underground in the business areas and overhead in the residential districts, and in the smaller towns they are mostly overhead bare copper (though at Worcester, aluminium wires are partly used), 3-wire distribution being generally adopted, but Cape Town in some parts has 5-wire distribution, and Paarl and Bloemfontein have 4-wire.

OVERHEAD MAINS.

In low tension work the Siemens and the sectional type of steel pole is common practice, varying in height from 20 to 35 feet in most cases, but on the coast there is an opening for a pole less affected by rust, and in the reinforced concrete pole we have an excellent substitute, which while being rather heavy to handle, has its advantages in life as well as in appearance.

The cross arms in use are wood, channel iron, and tubular steel. Johannesburg has probably the largest low tension network of overhead mains, amounting to no less than 191¾ route miles. With overhead mains many arrangements are put forward to dissipate the effects of lightning, which is very severe, especially in the towns of high altitudes, and the use of "earthed" guard wires on the top of the poles has for a long time been looked upon as a safe precaution, in addition to the use of arresters on the lines at frequent points, though, of course, no device will avert a direct stroke. There are, however, one or two towns which have not taken these precautions, and opinion is still very divided on the subject. Apart from the fact of the "earthed" guard wire being a precaution against lightning, it is also advisable from a safety point of view, by preventing a pole becoming dangerously charged owing to any of the mains coming in contact with same. The Government regulations provide that cradles or guard wires shall be erected under the mains at railway crossings and certain other places, but I am of opinion that with good construction there is little to fear from falling wires, and frequently the precautions taken in this regard as well as in the case of lightning, are more of a source of trouble in themselves than a preventative.

With high tension work, the bulk of the mains are laid underground, though in Johannesburg, Bloemfontein, Durban and Cape Town, a few of the routes are by overhead wires, Durban having extra high tension also for supplying the adjoining suburbs, and in the case of Bloemfontein the overhead H.T. mains are insulated wires. Durban is very fortunately placed in having practically the freedom of the whole of the roads for pole line construction, as the telephones are municipally owned as well as the tramways, the former being the one exception in South Africa, and with this one control many of the taller poles carry electric lighting wires on the top, telephone wires below, and under these the tramway span wires. In regard to the cost of overhead mains against underground mains there is very little difference in the first cost of a circuit for high tension work using the best class of material throughout, but a great saving is effected when an additional circuit is required, as the cost of poles do not then come in for consideration. In low tension work, however, there is a decided saving in favour of overhead mains, to say nothing of the saving in street lighting and house services costs.

UNDERGROUND MAINS.

Where underground mains are in use, the general practice is to use lead covered, armoured and served mains laid direct in the ground at a depth of from two to three feet, but there are a few cases where they are drawn in through pipes or ducts, or laid in a trough filled in solid with bitumun. In Durban a charge of 1/9 per yard of running trench is made by the roads department for reinstating after any excavations. Various dielectrics are in use, such as rubber, fibre, bitumen and paper, and cables laid over twenty years ago of vulcanized rubber insulation, seem as good to-day, as far as the rubber and wires are concerned, as when laid, but rubber cables are out of court on account of the price, and a very excellent type is the paper insulated cable which is universal the world over. The jointing of cables have undergone many improvements in past years, and where at one time joints were made by screwed fittings in a cast iron box filled up solid with special compound, the common practice now is to sweat it all up solid and insulate with tapes, after which a lead sleeve is wiped on, and in the hands of a careful plumber-jointer there is no more fear of a joint giving out any more than the cable itself. Too much attention cannot be given to the matter of joining all the armourings of the cable through and bonding them whenever opportunity offers to any rails or pipes. Faults on underground mains will, however, occur even with the best construction, and their localization is one that has to be carried out with as little delay as possible, for which there are no end of elaborate instruments. By adopting a system of ring main and the free use of inter-connecting switch pillars, great relief can be afforded, as the fault can then be localized between any two pillars and at the same time supply can be maintained by the duplicate route that exists.

In extra high tension mains Cape Town has about 20 miles laid, with some routes at 11,000 volts, and Johannesburg has the longest routes of both high and low tension, with 61½ miles of the former and 143½ miles of the latter.

RECORDS.

Too much stress cannot be put upon the importance of record keeping, the observations of which all point to where the economies may be exercised, and often leads to the prevention of interruption of supply. CO_2 Recorders show us that the best use is being made of the coal in the boilers, and Flue Thermometers also guide us, while Water Meters help us to keep an eye on any wastage in that direction, and so on.

The numerous instruments on the switchboard guide us in the loading of any particular generator or cable by which load factors, etc., are arrived at.

In distribution, periodical tests are taken as to the insulation of the cables, by which faults are detected before a breakdown happens; in the sub-stations are various meters by which the load on each transformer or feeder, etc., can be observed, and any tendency to overload is at once noted.

Elaborate plans show us where the cables are laid, their type, size, position of joints, house services, etc., and this is one of the most important of records in case "out of sight" may result in "out of mind." A strip map of one street only, assembled in a loose leaf book, is one form of record with say a scale of 20 feet to an inch; another form is by a large map embracing a certain block of streets. In overhead mains, though a plan is not perhaps essential, as the work can always be seen, it is nevertheless important, for at a glance the engineer knows exactly what the position is at any spot. A card system is one that can well be applied to many records, such as meters, house services, costs keeping, etc.

SUB-STATIONS, Etc.

These are provided with either the static or the rotary type of transforming gear, the first for reducing the high tension to low tension for distribution to consumers in the adjoining area, and the second for converting the current as supplied from say alternating to continuous or vice versa. The location of sub-stations is a matter not easily contended with, and while their natural position is in the centre of the area supplied, it is not always that space permits above ground, so that we sometimes find them underground with a small entrance shaft leading thereto from the roadway or footpath.

In some few cases private buildings are, however, used. Where the load is not so heavy as in the residential portions of the town, one or perhaps two small transformers may be sufficient, in which case we often find transformer kiosks, pillars, or pits, together with generally separate pillars containing the switch gear for the various circuits.

In the case of transformer pits, these should be arranged with drainage, and in the case of Durban the Berea is admirably adapted, as many suitable positions are to be found for pits, from the bottom of which a length of about say 100 feet of drain pipe leads into the guttering down the hill. On each side of the pit is fixed a switch pillar for high tension and low tension respectively, and these pillars also act as vents for the pit. The practice of hanging transformers on poles, while common in America, is conspicuous by its absence, with about two exceptions only.

Rotary sub-stations are in use in Johannesburg for converting the alternating current 2-phase, 3,300 volts to direct current 600 volts, and in Durban one sub-station is in use for converting alternating current 3-phase 6,600 volts to direct current 550 volts, and some few other towns adopt similar measures, particularly Cape Town.

In transformers we find two types: the air and the oil cooled, but the latter type represents the best practice.

As an example of the number of transforming points in Durban, there are a total of 79 points as follows:— 14 static sub-stations above ground and 3 below, and 1 rotary sub-station; 15 transformer pillars, 22 pits, and 24 in buildings, the largest sub-station having a capacity of 300 K.W., whilst Cape Town's largest sub-station has a capacity of 1,200 K.W.

TRAMWAYS.

Private companies were first in the field in nearly all the towns in South Africa with both horse and electric tramways, and even to-day the electric tramways at Cape Town, Camps Bay, Port Elizabeth and Kimberley are in the hands of such. Other towns, however, have acquired what were in some cases companies' undertakings operated by horses, since which time they have been electrified by power obtained from the lighting station. Boksburg and Germiston, however, purchase their current for tramways as they also do for lighting, and have adopted the trackless system, as has also Bloemfontein, the system adopted by all the other towns being the overhead trolley; in all cases direct current being supplied at from 500 to 550 volts. To what degree tramway extensions may take place in the future there may be some doubt, as the introduction of the petrol-electric vehicle and the electric vehicle with the Edison battery, which is running with so much success, may eventually lead to such adoption for future requirements. Already we see examples of same, which serve as feeders to the main tramway routes, as at Johannesburg, Pretoria and Pietermaritzburg, while in the case of Benoni the municipality has lately inaugurated a system of electric busses entirely, there being five in number. Other uses are made of the tramways besides carrying passengers, such as road sprinklers and freight cars, and Durban has even a parcels collection and delivery system, which alone brought in a revenue of £790 last year. A universal gauge of 4ft. 8½in. is adopted for the track. The steepest grade and sharpest curve is at Cape Town, being 1 in 8 and 28 feet radius respectively, while in miles of track Johannesburg has just a little over 65 miles, or 42 route miles.

In charges for current for tramways, Durban and Bloemfontein are the only two instances where one penny per unit is charged. In road maintenance, some towns charge the tramway department half cost, while others pay in full. A wayleave is charged in the case of Camps Bay Tramway Co. of £50 per mile.

In fares, the penny cash fare does not yet apply to all towns. Pietermaritzburg, Cape Town, Bloemfontein and East London however do so.

STREET LIGHTING.

Many changes have taken place in street lighting in the last few years, and whereas at one time all large towns used arc lamps for their principal thoroughfares, the introduction of the high candle power metal filament and half-Watt lamp has practically forced the arc lamp on the scrap heap.

For the residential districts incandescent lamps have always been the custom. The principal towns light up from dusk to dawn, while the smaller towns switch off about midnight, and generally on moonlight nights.

The location of lamps is a point which requires careful consideration, and centre or side pole lighting is often to be found. On tramway routes with centre poles that is practically the only way, but special centre poles in these days of fast locomotion are being looked upon as an obstruction, and in my opinion centre lighting from span wires is difficult to improve on. Some few towns are even now adopting this style of construction, which permits of the pavements under the verandahs being lighted as well as the roads, and where trees line the footpaths, as they so frequently do in South Africa, there is far less obstruction to the light than there is in the case with side poles.

The switching of street lamps is in many cases carried out by time switches, though one or two towns have distant solonoid control, and the patrolling or reporting of lamps out is left generally for the police, who are the proper body.

The maintenance of street lighting is an important matter as well as costly, but thanks to the introduction of the modern vehicle (which rightly is an electric one), Durban, by way of an example, is able to carry out all its repairs and replacements (and there are over 2,500 lamps to look after), with one man and two natives, whereas at one time it required three men, six Indans and four natives.

HOUSE SERVICES, Etc.

Connections to houses are made by overhead as well as underground mains, and in the case of the former the class of wire used, though not highly insulated, offers some sort of protection to those who might come in contact with same. It is a double or triple braided wire sometimes compounded, and withstands the weather conditions very well. The application fee covers the cost of the service up to a certain distance, beyond which charges are made, in some cases half cost and in others the full cost of the extra material required.

There are a vast variety of meters in use, of the clock and cyclometer dial, the slot meter in a few cases, and the two rate meter, which is generally two ordinary meters controlled by a clock which cuts the meters in or out of the circuit at a pre-determined time. There are few towns who do not charge for meter rent, which varies from 6d. to 2/6 per month, which, in the case of

S.A. Municipal Electrical Undertakings.

TARIFF OF CHARGES (Gross).

TOWN.	LIGHTING AND HEATING. L.=No. Lamps. S.=Sliding Scale. N.=Norwich. F.=Flat. R.=Rooms. W.=No. Watts.	POWER.	MUNICIPAL. Light.	Power.	Street Lamps.	Trams.	Bulk.	Total Revenue.	Average Revenue per Unit Sold.
								£	Pence.
Aliwal North ..	L. 2/3. above minimum 6d. and 4d.	S. 4d. and 3d. ...	...	...	...	...	...	2,059	7·77
Bloemfontein ...	S. 10d. to 1d. (business) N. 10d. above min. 2½d. and 1d. (private)	S. 4d. to 1d. ...	...	...	£2,500	1d.	...	26,903	3·19
Cradock ...	F. 1/-	F. 4d.	...	...	6d.	...	...	1,841	11·1
Capetown ...	Cooking only, 1·69d. to 1·25d.; Special hot water rate 2 Rate 8d. & 4d.: Units 7d. above min. 1½d. to 1d.	Elec. vehicle charging 1½d. S. 2d. to ¾d. ...	... 2¾d.	... 2¾d.	... approx. 2¾d.	... ...	... 1·5 & ·75	... Current only ? 140,740	... 2·51
Ceres	F. 1/-.	... ...	1/-.	...	1/-.	...	...	535	14·2
Durban... ...	2 Rate 5d. and 1d., or 2d. (business) N. 5d., above min. ¾d.: or F. 5d.: out of borough 6d. and 7½d.	Restricted hr. ·375d. S. 2d. to ½d. ...	4d.	·85	£2-50 c.p. £7·8—400 c.p.	1d.	·75	116,008	1·39
Ermelo... ...	S. 1/-. and 9d.	9d.	8d.	8d.	9d.		...	3,261	16·35
East London ...	F. 9d.: 2 Rate 9d. and 3d.: Cooking only, 3d.	S. 3d. to ¾d. ...	...	...	...	1½	3 and 1·5	22,933	3·73
Greytown ...	S. 1/-. to 9d.	S. 6d. to 2d. (day)...	...	...	£346	...	...	2,105	9·05
Heidelberg ...	S. 1/-. to 6d.	F. 4d.	1/-.	4d.	7½d.	...	...	1,310	12·37
Harrismith ...	S. 1/-. to 9d.: Domestic, 4d.: Shop windows and verandahs, 6d.	S. 4d. and 3d. ...	Total	for all	£800	...	...	3,344	6·90
Johannesburg...	R. 6d., above min. 1½d.: 2 Rate 1½d. and 6d. to 2d.	(a) £5¼ per K.W. + ¾d. (b) 2 Rate 1½d. and 6d. to 2d.	6d. to 1½d.	6d. to 1½d.	1d.	1·379	...	296,383	2·83
Krugersdorp ...	F. 6d.	S. 3d. to 1½d. (day)	4d.	1d.	4d.	...	...	10 211	3·25
Randfontein ...	F. 6d.	S. 3d. to 1½d. (day)	6d.	4d.	6d.	...	...	1,744	5·05
K.W. Town ...	S. 1/-. and 10d.	S. 3d. to 1d. ...	...	...	5½d.	...	...	6,906	5·57
Kroonstad ...	F. 9d.	S. 6d. to 3d. ...	6d.	3d. & 2½d.	4½d.	...	...	7,646	3·55
Klerksdorp ...	S. 9d. ond 6d.	F. 3d.	6d.	3d.	6d	...	...	3,080	6·26
Ladysmith ...	N. 9d., above minimum 3d.	S. 3d. to 2d. ...	Total	for all	£1,050	...	...	5,249	3·49
Newcastle ...	S. 10d. to 8d.	S. 10d. to 8d. ...	...	...	£650	...	...	2,101	8·52
Oudtshoorn ...	S. other than private dwellings 1/-. to 8d.: N. 1/-., above minimum 3d.	2 Rate 9d. and 3d.	...	...	10d.	...	...	5,050	9·0
Port Elizabeth	Other than private 8d. up to 400 units: 2 Rate 8d. and 3d.: N. 8d., above min. 1d.: Shop windows &c.. 6d.	°. 1½d. to ¾d. ...	...	...	...	...	2d. & ¾d.	36,554	4·24
Potchefstroom	R. 9d.. above minimum 4d.	S. 4d. to 3d. ...	...	...	6d.	...	...	6,257	10·91
P. M. Burg ...	S. 9d to 6½d.: Heating 2d.	(a) £3 per H.P. + 1½d. (b) S. 3d. to 1½d.	6d.	3d. & 1½d.	6d.	1½d.	2d. to ·84d.	30,169	3·44
Pretoria ..	2 Rate 6d. and 3d.: F. 6d.: N. 6d., above minimum 2d.	S. 3d. to ¾d. ...	6d.	3d. to ¾d.	£3-50 c.p. to £40 2,000 c.p.	1½d.	...	61,537	3·03
Parijs	W. 9d.	F. 3d.	...	...	9d.	...	...	1,213	8·59
Paarl	S. 10d. to 7d.	F. 3d.	...	...	£3 each	...	...	...	...
Queenstown ...	F. 1/-.: 2 Rate 1/-. and 6d.	S. 6d. to 2d. ...	6d.	6d.	6d.	...	...	4,419	6·98
Senekal ...	S. Boarding Houses, Shops, &c., 1/-. to 3d.: R. 1/-., above min. 4d.: S. Hotels and Clubs, 1/-. to 4d.	S. 3d. to 1d. ...	...	...	...	...	...	...	...
Stellenbosch ...	S. 1/-. to 9d.	F. 3d.	Total	for all	£503	...	...	2,438	7·44
Uitenhage ...	S. 1/-. to 6d.	S. 4½d. to 2d. ...	...	...	6d.	...	...	...	...
Winburg ...	S. 1/-. and 6d.	F. 6d.	...	9d.	£180	...	...	1,368	9·97
Wellington ...	F. 1/-.	F. 4d.	1/-.	4d.	...	...	...	2,504	...
Worcester ...	F. 1/0½d.: Bioscopes 5d.: S.A.Rlys. 4½d.	S 4d. to 3d. ...	...	...	...	...	...	2,238	8·67

Pietermaritzburg, brought in a revenue of over £1,000 last year. Very little has been done in the way of publicity campaigns in South Africa. The lack of opposition no doubt accounts for it, but there are a few isolated cases where the municipalities advertise and have show-rooms.

WIRING RULES.

Generally the Wiring Rules are all based on the Rules of the Institution of Electrical Engineers and Fire Office Rules, though several towns publish their own, which embody special rules to suit the local conditions. Some won't allow casing or bobbin work, one other prefers it, some again carry out consumers' wiring, but the majority are against municipal trading in this line, but roughly 50 per cent. of them have adopted assisted wiring, while a few hire out apparatus.

Where 3-wire distribution exists, a few towns take in the 3-wires where the demand warrants it; some even do so for loads as small as 1,000 watts, which may seem an unnecessary expenditure, as the balancing of the load on the distributing mains could be as easily carried out by balancing the several houses as a whole.

TARIFFS.

The question of tariffs is about as complete a subject as any in this paper, and seeing the discussion stands adjourned on the paper read by Mr. John Roberts, Borough Electrical Engineer of Durban, before the last Convention of the South African Municipal Electrical Engineers, it is hoped many points will come up for consideration at the present Convention.

We find all sorts of tariffs from as low as .375 pence for a restricted hour supply at Durban to as high as 1/- per unit at several of the smaller towns, and by going beyond the Union we find a charge of from 1/6 to 2/- at Bulawayo—enough to make one's mouth water.

A few towns adopt the flat rate, but others have a large variety, such as sliding scale, Norwich system of rateable value, number of rooms, number of lamps installed, generally divided into various classes of supply such as lighting, cooking, motors, shop windows, restricted hour, bulk, hot water heaters, and so on. Discounts are given in quite a few towns for payment within about seven days, up to as much as 25 per cent. in one case, where bad debts are unknown with such an inducement. With many of the systems adopted there is a minimum charge imposed, and in the case of motor supply the charge is often based on the horse-power demanded. The diversity factor of the load is one that has a great bearing on the assessing of the fixed or standing charges which may be expressed as follows:

$$\text{Diversity Factor} = \frac{\text{Sum of Consumers Max. Demands}}{\text{Combined Max. Demands on Plant}}$$

For instance, public and business lighting (internal) has a diversity of practically unity, whilst cooking may be as high as 20. In departmental charges for street lighting it will be seen by the table that some towns charge a lump sum, while others charge per lamp or per unit. Durban, it will be seen, is cheapest all round, the lighting rate having been lowered to 5d. per unit since August, 1917.

STAFF.

In the larger towns the borough electrical engineer is sometimes general manager for both tramways and lighting, and in the medium sized towns he is sometimes borough engineer in control of all branches of engineering, while in the smaller town he may have even to take a shift and read his own meters, etc. The reading of meters is left to the electrical department as a rule, but the payment of the accounts, in fact the whole of the control of the finances, is in the hands of the town treasurer in practically every case. For dealing with breakdowns on the distribution, the practice is for one of the mains engineers to remain within telephone call, and a stand-by gang is kept at the power station at his disposal, being provided with an electric or other vehicle, which carries the ladders, tools, natives, etc. It may be of interest to mention that the total European staff of all our municipal stations is about 800 in number, exclusive of tramway staffs.

FINANCIAL.

FINANCIAL YEAR.

Unless otherwise noted, the references in the paper are for the period ending during the year 1916, and in this connection uniformity might well be applied. In South Africa we find municipal financial years ending at all sorts of periods, some at the end of the calendar year, others at the half-year, some at March, others at June or July, and so on.

Even with the Government, we find the financial year ends at March, and industrial census and income tax returns at June, and statistical returns as at December are even now under consideration. As the municipalities have by law to make certain Government returns, it is thus a very difficult matter to make the necessary extractions to fit in with the period required.

CONTROL.

The question of the financial control is as contentious a matter in South Africa as at Home, and in practically every town the control is vested in the hands of the financial head of the Corporation—the town treasurer.

Many arguments are put forward both for and against this form of control, but apparently no evidence has been sufficiently strong to take away as it were any portion of the town treasurer's birthright, for finances are the first birth in a municipality, and electricity is perhaps the last, but its days of infancy are over, and that may account for the bone of contention.

In favour of it may be held the fact that the town treasurer is a specialist on finance, but against it is often held out the loss of expediency and economy caused by the unnecessary duplication, and that the electrical department has to pay the town treasurer's department for collection of accounts, etc., which it would probably do at far less cost. It would also enable the electrical engineer to always have before him detail costs of any technical branch, which details the town treasurer may not keep, as such details do not concern him.

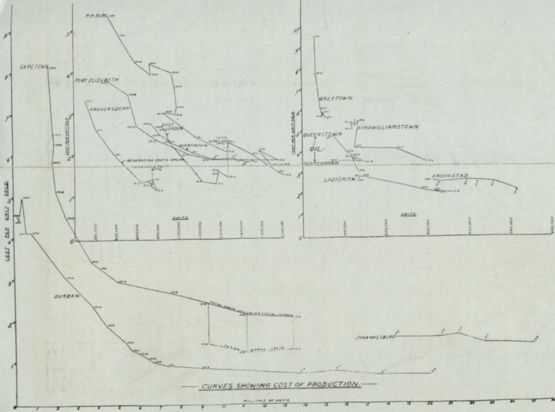
Further, in making recommendations to the Council on, say, alterations to tariffs, or advantages of more economical plant, or other matters in which finance bears great weight, figures could be extracted by the technical man better than by the purely financial man, to show in what way financial benefit would accrue, and it is hoped the Municipal Electrical Electrical Engineers' Association will support such an arrangement.

With the recently introduced Government audit, as well as the inter-municipal audit, I fail to see why a proper control cannot be kept, if the electrical engineer did the accountancy, and there would be no continual overlapping as is now the case. Before, however, such a state of affairs can come about it is necessary to have some universal form for financial statements, as is the case at Home, and the tables as published in the "Electrical Times" may be looked upon in a truly comparative sense.

Even town treasurers have various ways of accountancy, and certain charges may often be lumped together under one heading, but the electrical engineer has a still greater variety of ways, which at once weakens their case of ever controlling finance. Similar remarks may be made in regard to stores, and though the electrical engineer is generally in control of his own stores, in the few larger towns the control is in the hands of the general storekeeper, who when he buys has to consult the electrical engineer as to details, and when the goods arrive has again to consult the electrical engineer if the goods are up to sample.

WORKING COSTS.

On account of the various ways of costing adopted, it is practically an impossibility to make comparisons with any degree of accuracy, but in generation costs they are more similarly sub-divided, and some useful



CURVES SHOWING COST OF PRODUCTION.
COST PER UNIT SOLD
MILLIONS OF UNITS
UNITS
CAPETOWN
DURBAN
P.M.BURG
PORT ELIZABETH
KRUGERSDORP
EAST LONDON
BLOEMFONTEIN
GENERATING COSTS ONLY
TOTAL WORKS COSTS
GREYTOWN
KINGWILLIAMSTOWN
QUEENSTOWN
OIL
OUDTSHOORN
LADYSMITH
KROONSTAD
JOHANNESBURG