PROCEEDINGS

OF THE

FIRST CONGRESS

OF THE

Association of Municipal Electrical Engineers

(UNION OF SOUTH AFRICA)

Held at Johannesburg, South Africa,
From Monday, November 15th, to Saturday, November 20th
1915.

[PRICE FIVE SHILLINGS]

E. H. Walton & Co.,
Printers,
Port Elizabeth.

INDEX.

Page

PROCEEDINGS

OF THE

Association of Municipal Electrical Engineers

(UNION OF SOUTH AFRICA.)

FOUNDED 1915.

EXECUTIVE COUNCIL:

President:

PROF. J. H. DOBSON (Johannesburg).

Vice-President:

W. J. LONG (Cape Town).

Members of Council:

J. ROBERTS (Durban).
B. SANKEY (Port Elizabeth).
W. BELLAD-ELLIS (Queenstown).

Hon. Treasurer:

E. T. PRICE (Johannesburg).

Hon. Secretary:

F. T. STOKES (Johannesburg),
to August, 1916.

B. SANKEY (Port Elizabeth),
From August, 1916.

Set 34 ems

BACK ROW.—M. McDonough, Bethlehem. J. R. English, Heilbron. T. Jagger, Ladysmith. T. Millar, Harrismith. J. Roberts, Durban (Member of Council).
T. C. Wolley-Dod, Pretoria. B. Sankey, Port Elizabeth (Member of Council). E. T. Price, Johannesburg (Hon. Treasurer).
F. Castle, Oudtshoorn. G. H. Swingler, Cape Town.
FRONT ROW.—W. Bellad-Ellis, Queenstown (Member of Council). F. T. Stokes, Johannesburg (Hon. Secretary). W. F. Long, Cape Town (Vice-President).
J. H. Dobson, Johannesburg (President). A. S. Munro, Pietermaritzburg. W. H. Blatchford, Greytown. 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 19th, 1915.

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, and three 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.)

AT JOHANNESBURG,

FIRST ANNUAL CONGRESS,

NOVEMBER, 1915.

Programme of Proceedings.

Monday, 15th. 10 a.m.—Welcome by the Mayor and formal opening of Congress. Election of Officers, etc., and other formal business.

1 p.m.—Luncheon at the Rand Club by invitation of His Worship the Mayor, Norman Anstey, Esq.

2.30 p.m.—Visit to the Rosherville Power Station of the Victoria Falls Power Company.

Tuesday, 16th. 9 a.m.—Visit to the Crown Mines.

2 p.m.—Meeting. Presidential Address. Paper and discussion.

Wednesday, 17th. 10 a.m.—Meeting. Paper and discussion.

12 noon.—Leave for Randfontein.

1 p.m.—Lunch at Grand Hotel, Krugersdorp, by invitation of Hubert Davies, Esq.

2.30 p.m.—Inspection of Randfontein Power Station.

Thursday, 18th. 10 a.m.—Meeting. Paper and discussion.

8 p.m.—Meeting with local Institute of Technical Engineers.

Friday, 19th. 10.30 a.m.—Meeting. Rules and Constitution and general business.

2.30 p.m.—Visit to Johannesburg Power Station and Distribution System and to the Municipal Abattoirs and Live Stock Market.

Saturday, 20th. 9 a.m.—Meeting. General business and conclusion of Congress.

PROCEEDINGS

OF THE

FIRST ANNUAL CONVENTION

OF THE

Association of Municipal Electrical Engineers,

(UNION OF SOUTH AFRICA.)

Johannesburg, November 15th to November 20th, 1915.

MONDAY, NOVEMBER 15th, 1915.

The first meeting was held at 10 a.m. in the large Committee Room of the Johannesburg Town Hall, which was kindly placed at the disposal of the members throughout the week.

The delegates were welcomed by His Worship the Mayor, Norman Anstey, Esq., to whom the thanks of the members were duly accorded for his hearty welcome to Johannesburg and for the facilities given by the Municipality, after which the meeting commenced.

Professor J. H. Dobson was unanimously elected President and Mr. W. F. Long Vice-President of the Association for the ensuing year.

After discussion, it was proposed by Mr. John Roberts, seconded by Mr. R. Mortimer, that the next annual meeting be held in Cape Town, about the end of September, 1916. Carried.

Membership.

The question of membership was discussed at length.

Mr. B. Sankey proposed: "That members at the time of their election be the Chief Electrical Engineers engaged on the Permanent Staff of an electrical undertaking owned by a local authority in the Union of South Africa, and any duly qualified assistants whom they may recommend for election." This was seconded by Mr. Castle and carried.

It was proposed by Mr. Poole, and seconded by Mr. John Roberts, "that Tramway Managers be accorded membership." Carried.

Constitution of Council.

It was proposed, seconded, and carried: "That a Committee be formed to draw up the rules, etc., and this Committee to report as soon as possible to the meeting." The following were elected to serve on this Committee:—Messrs. John Roberts, B. Sankey, Wooley-Dod, W. Long, T. Miller, with the President.

Honorary Secretary.

Mr. John Roberts proposed, seconded by Mr. B. Sankey: "That Mr. Stokes be appointed Hon. Secretary." Carried.

Subscription and Printing of Proceedings, etc.

After discussion, Mr. Bellad-Ellis proposed, seconded by Mr. Long, that the question of subscription be left over for the time being. The matter of printing of proceedings, etc., was also left over.

At 1 p.m. the delegates were entertained to lunch at the Rand Club by His Worship the Mayor, Norman Anstey, Esq., and there were present besides the delegates:—

Councillor T. F. Allen, Chairman Tramway and Lighting Committee.
Professor John Orr, Johannesburg School of Mines and Technology.
G. S. Burt Andrews, Esq., Town Engineer.
W. Ingham, Esq., Chief Engineer, Rand Water Board.
F. W. Mills, Esq., Chief Electrical Engineer, South African Railways.
T. C. Otley, Esq., Victoria Falls Power Company.

At the conclusion of the lunch, His Worship the Mayor accorded a most hearty welcome to the delegates to Johannesburg, and wished success to the new Association, assuring them of the hearty support of the Johannesburg Municipality.

The President suitably responded.

Councillor F. T. Allen proposed the health of the newly-elected President, which was received with acclamation, and to which the President duly replied.

In the afternoon the members visited the Rosherville Power Station of the Victoria Falls Power Company, Ltd., by invitation of Bernard Price, Esq., the Chief Engineer to the Company.

In Mr. Bernard Price's unavoidable absence, the delegates were received by Mr. T. C. Otley and Mr. R. C. Bryden, and after inspecting the plant were entertained by the Company in their large recreation hall.

A very hearty vote of thanks was given to the Company for their kindness, which was suitably acknowledged by Mr. T. C. Otley, after which the party returned to Johannesburg at 5.30 p.m.

TUESDAY, NOVEMBER 16th, 1915.

The delegates visited the Crown Mines, Ltd., by invitation of the General Manager, being received on the mine at 9 a.m. by Mr. A. T. Brett, the General Manager, and Mr. Simpson, Underground Manager.

The party was conducted down the mine and shewn the large electric pumping and other plant, after which the surface plant was inspected, including the large electric winders.

The Assay Offices were then visited and the smelting process viewed.

The party returned to Johannesburg at 11.30 a.m.

At 11.30 a.m. the Sub-Committee met and drafted provisional Rules and Constitution to be submitted to the full meeting for their approval and ratification.

In the afternoon the Congress met at the Town Hall at 2 p.m., when the President delivered his Presidential Address.

PRESIDENTIAL ADDRESS—MUNICIPALS.

Gentlemen,—I thank you for the honour you have done me in electing me as the first President of the South African Municipal Electrical Engineers' Association. I realise that a great responsibility devolves upon me, and I can assure you that I shall do my utmost to justify the confidence you have reposed in me. I notice that I am down to present a Presidential Address. A President of a technical institution as that now formed is usually given an opportunity of presenting an address to the members on a subject of general interest, and this explains why the item is arranged on the programme. This opportunity is afforded the President either in his introductory or inaugural remarks immediately after his election, or in his valedictory address when he vacates the presidential chair to his successor. I propose on this occasion to content myself with a few general remarks.

In the first place, let me state how gratifying it is to me that you have given such hearty response to the formation of the South African Association of Municipal Electrical Engineers, and to Mr. John Roberts in particular my thanks are due for suggestions and assistance in bringing you together at this inaugural conference. To Mr. Stokes is due the thanks of the members for undertaking the clerical and introductory work during the formation of the Association. The Association being thus formed, I propose now to give some indication as to the lines upon which its usefulness will be appreciated. Engineer members should endeavour to get members of their various Committees interested in its work, and in this way the work of the Association will be appreciated and officially recognised.

There are many problems in Municipal Electrical Engineering which require consideration, with special reference to the conditions which exist in South Africa. In the first place, in the absence of a body comparable to the British Board of Trade and Local Government Board, the newly-formed Municipal Electrical Association would be a body to which Municipal Electrical Engineering problems could be referred for expert advice connected with the spending of money for public undertakings. The Association might also be a body which might standardise electrical systems throughout South Africa, more particularly with regard to voltage and frequency of supply. In this way each Municipality would be able to buy in the best markets on thoroughly standardised materials such as lamps, motors, etc.

Again, the question of electricity tariffs on a Municipal electric system is a problem peculiar to every public lighting system. An interchange of ideas as to how to deal with idle plant outside the hours of peak load, and suitable tariffs to obviate the necessity of increasing the number of meters is bound to result in advantage to every Municipality.

Another question is that of meter reading. Some Municipalities have water meters, electrical meters and gas meters, and as to whether there should be separate meter readers for each department or whether one meter reader should read all Municipal meters at one stand or house, be they water or electricity meters, and whether the meters should be read during a certain period of the month or over the whole month, are certainly matters in which the public generally are particularly interested.

The question as to whether electricity and water departments should introduce methods of advertising in various ways is also a matter well worthy of the consideration of Municipal Engineers.

Another matter which has doubtless occurred to many Municipal Electrical Engineers, especially in the large towns, is that of "Licensing of Electricians." In the case of Johannesburg, we have got to the stage of the Council having approved of draft bye-laws for the licensing of electricians, which bye-laws are now before the Provincial Administrator for his sanction. It is contended by many that the licensing of electricians upon reasonable lines and without any hardship to those who are bona fide electricians would result in a greater protection to the public and a greater satisfaction to those in charge of Municipal electrical distribution systems.

Turning next to the question of Municipal Tramway undertakings, with which South African Municipal Engineers are often closely associated, there are many problems in this country which are essentially different to those in other countries. In the first place, there is the question of "white" versus "coloured" people and the controversial points connected therewith. Again, there is the question of the Postmaster-General's requirements in connection with the return circuit of electric tramways. In 1911 an Act was passed entitled "The Post Office Administration and Shipping Combinations Discouragement Act, 1911," giving the Postmaster-General power to insist upon the introduction of the British Board of Trade Rules. There are many cases in which such rules, if insisted upon, would retard tramway progress, and I can conceive of no better method of dealing with points of controversy on this subject than by their being discussed before this Association. To make this point quite clear, there may be required in some part of South Africa a tramway extension through a suburb where there is no telephone reticulation or other underground works; I submit that in such cases the cost of the tramway scheme should not be burdened with capital to comply with rules unnecessarily, but that the dangers of interference with existing underground works should be the guiding factors, and not stereotyped rules and regulations.

Another matter connected with the provision of tramways is that of extensions to the more sparsely populated suburbs of a large town, as well as the initiation of tramways for small towns. Various Municipalities have embarked on systems to obviate the large capital expenditure of the ordinary tram car on steel rails; such systems are those of railless electric traction, and petrol, petrol-electric and electric omnibuses. It would be of immense public interest if those who have figures on the various systems referred to would present them to an association of this description for comparison and discussion. Owing to the different conditions it is impossible to accept home figures.

No doubt many other subjects for discussion will occur to you, but I think enough has been said to indicate the lines upon which the Association might prove of great value to the Municipalities and public of South Africa. There are the great advantages which will be derived by an exchange of visits and to hold the Annual Congress or Meeting at some different place each year. In this way we shall doubtless be able to copy that which appears to be an improvement on our own systems, and to avoid that which is seen to be undesirable on others.

You will see from the Agenda for the week that the Council of the South African Institute of Electrical Engineers has kindly invited the members of this Association to their meeting on Thursday evening next; the paper down for reading is "The Distribution Plant of the Johannesburg Municipal Electric Supply System," by J. H. Dobson. You will also note the visit to the Municipal Power Station on Saturday next. To those who are unable to stay until Saturday will be afforded an opportunity of visiting the Power Station and Distribution System at a time convenient to them.

Finally, I again thank you for the honour you have done me, and with the assistance of your Council I shall do all I can to further the interests of the newly-formed Association of Municipal Electrical Engineers.

Mr. Wolley-Dodd (Pretoria) proposed a hearty vote of thanks to the President, which was seconded by Mr. B. Sankey (Port Elizabeth).

Mr. W. F. Long, City Electrical Engineer, Cape Town, then read the following paper:—

SOME NOTES ON THE PREVENTION OF CORROSION IN CONDENSER TUBES.

The study of the prevention of corrosion in Condenser Tubes has probably been given far more attention by the Naval Authorities and the Mercantile Marine than other steam users, owing to such corrosion being more marked with the use of the sea for circulating water purposes; and it is therefore not usual for any protective device to be supplied by manufacturers of condensers for use in Power Stations, unless specially asked for.

It is true that some makers fit zinc or cast-iron plates to the tube-plate of their condensers; but the writer's experience in this direction is that where the water used for circulating purposes has a tendency to attack the tubes, these plates only aggravate the trouble.

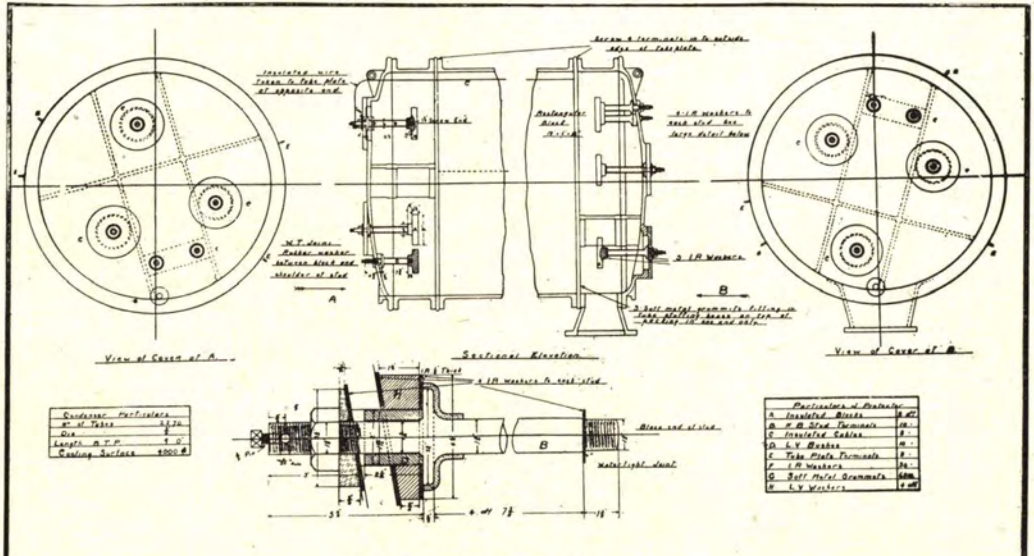
Since the adoption of the use of the water from Table Bay for circulating purposes at the Cape Town Corporation Power Station, we have from time to time had considerable trouble through corrosion of condenser tubes; but the inconvenience of having to occasionally shut down a leaky condenser to renew a tube was not so marked with Reciprocating Plant as on the adoption of Turbine Driven Units.

The failure of tubes in the condenser of the first Turbo Alternator installed, however, was so frequent after about six to nine months' running, that it became necessary to institute careful enquiries into the various schemes adopted by makers for the prevention of this trouble.

Our original enquiries, which were directed towards ascertaining the best alloy recommended for the use of condenser tubes, brought to light the fact that with the use of sea water for circulating purposes, tinned tubes had been entirely discarded by the Admiralty and Mercantile Marine for some years.

This information came somewhat as a surprise, as in all specifications issued for Condensing Plant required, from time to time, the provision of tubes tinned both inside and outside was specified, and also that the Condenser must be designed for use with sea water.

In order to assist makers in arriving at a satisfactory solution of the trouble, samples of the faulty tubes were sent to England for examination, but with no very satisfactory results, makers stating that in their opinion the pitting was due to some acid finding its way into the Condenser, thereby setting up a chemical action over which they had no control. The only useful information obtained from the makers of this particular Condenser was that the tubes were better untinned, and that the Admiralty had discontinued tinning tubes for some years.



Cape Town Protector Nº 204.

Further investigations through other sources resulted in the following useful information being obtained:—

"The pitting of brass condenser tubes appeared to be a very vexed and difficult problem, and the views held by different people as to its cause were very different. The Institute of Metals has devoted attention to this subject for some years, and their latest reports state that local corrosion or pitting takes place much more readily when sea water in harbours is used for circulating, as compared with circulating water obtained in the open sea. Sea water always contains a considerable quantity of dissolved carbonic acid gas, and if the water is highly charged with this, it has a corrosive effect on brass. One cannot, therefore, go entirely upon the experience of Marine Engineers, and it seems to place a land station using harbour sea water much in the same case as coasting steamers and those which ply in brackish water, rivers, estuaries, etc.

Temperature in the condenser has also a good deal to do with the trouble, the positions where most corrosion is found being where the hottest steam is deflected on to the tubes. To minimise the chances of corrosion it is therefore quite clear that the cooling surfaces of the condenser must be very liberal for the amount of steam condensed so as to keep the temperature down, and overloading of the condenser, and thus raising the temperature should be avoided.

Pitting would appear to take place in the first instance owing to the zinc in the alloy becoming attacked at certain spots and leaving the copper behind in a spongy form. When the copper has lost its backing or support it is quickly worn away mechanically. Efforts have, therefore, been directed by makers to produce an alloy in which the zinc will not be attacked. The Admiralty use 1 per cent. of tin added to the usual alloy of 70 per cent. copper and 29 per cent. zinc. Muntz metal, which is 61 per cent. copper and 39 per cent. zinc is very subject to corrosion at the higher temperatures, but the Muntz Metal Company use a mixture containing 2 per cent. of lead for marine condenser tubes, which, from considerable experience obtained, appears to be the best metal for resisting corrosion. This mixture is 70 per cent. copper, 28 per cent. zinc and 2 per cent. lead, and is known as "Special Brass" or "Muntz's Nergandine." It appears proved that lead in this small percentage is a real preventative against the zinc being attacked, with consequent pitting and corrosion of the tubes. It is a curious thing that condenser tubes made of brass years ago, when copper and zinc contained so-called impurities of lead, etc., have lasted better than tubes of absolutely pure zinc and copper obtained by electrolytical processes.

In the Presidential Address of Sir Henry Oram, Engineer-in-Chief to the Fleet, he states that, after prolonged investigation, they came to include the following points in their specifications:—

1. The copper to assay not less than 99.6 per cent.
2. Scrap to be limited to ends removed from process tubes and not to exceed 20 per cent.

3. Total impurities not to exceed 0.625 per cent.
4. The amount bored out of castings to be not less than ¼ inch of diameter.

These conditions have held good from 1906 till last year, with the addition that electrolytic copper may be used, and he says that the success of tubes made to this specification, when coupled with some improvements in condenser construction, has well repaid the time devoted to this important matter.

In the Navy they are troubled with splitting of tubes more than by corrosion, although a much greater number of failures were due to corrosion. It is obvious that split tubes tend to allow a large quantity of sea water to mix with the condenser water, causing trouble in the boilers from brackish feed water, or necessitating the throwing away of the condensed water entirely.

One of the many orders issued by the Admiralty with a view to minimising corrosion in condenser tubes was an instruction to ships' engineers to drive the circulating pumps at high speed at frequent intervals, thus clearing the tubes of cinders, scale, etc.

Sir Henry Oram also states that in the Navy gun-metal ends for condensers have disappeared, being superceded by cast-iron, to the great advantage of the condenser tubes. The condenser shells have now also for some years been made of sheet steel, which, although not so durable as gun-metal, is sufficiently so, having regard to the probable life of ships.

With regard to the use of plates immersed in the water space, the Institute of Metals found that, although at first sight zinc would appear more suitable than iron, being more-electro-positive, this does not prove to be the case in practice, as the zinc gradually becomes covered with a layer of oxide which is electro-negative to brass and a poor conductor.

Therefore, for the protection of condensers, zinc has been largely replaced by iron, which is not only cheaper but more efficacious. The iron slabs are placed in the water boxes attached by bolts to the tube plates.

In Cape Town we had a clear proof of this, the condenser of the second Turbo Alternator having zinc plates attached to the tube plates, and corrosion appearing within the first few weeks of starting up. On removing the water boxes it was found that the plates had a scale formed on them, showing that they were not acting as intended, and were no doubt aggravating the trouble.

There appears to be nothing very definitely proved as to the action on tubes which are tinned This coating does not prevent the uniform total corrosion over the whole surface, but it prevents the zinc in the alloy being attacked locally. If one finds that tubes in one position in the condenser are attacked while others in a different part are not corroded, this is due to the uneven distribution of temperature throughout the condenser. The investigations show that it is not advisable to divide the condenser into separate nests of tubes through which the water passes in succession, because the water gains in temperature as it flows through these different lots of tubes, and the last lot are subject to much higher temeperature than the first lot where the cold water enters. From the corrosion point of view it is better to introduce a separate water inlet and outlet to each nest of tubes in the condenser. If there is any choking of the tubes, this will assist corrosion because the temperature will be thereby raised. To prevent this the speed of water through the tubes should not be less than 300 feet per minute, and preferably 360 fet per minute.

The Wallsend Slipway and Engineering Company, to whom the matter was referred, informed us that it was their usual practice to fit untinned condenser tubes in Marine work; tinned tubes, they say, are seldom used.

They advised me to refer to the Cumberland Engineering Company and the Harris Feed Water Filter Company, both of whom have a system of dealing with corrosion in condenser tubes.

The former Company appear to have made this a special study for many years, starting in Australia on ships, and then in the Sydney Electric Lighting Station, where they effected the protection of boiler and condenser tubes from pitting; they have now been taken up by the Cunard, White Star and other big lines of steamships, in which their system has proved to be very efficacious against pitting and corrosion, with the additional advantage of loosening scale. They showed our representative an experiment proving that plates of zinc put into condensers and boilers as a preventive against corrosion become oxidised and after a time change over in polarity from electro-positive to electro-negative. This is an extremely remarkable effect, but one which can be easily demonstrated with a piece of old zinc as compared with a piece of new zinc. It will thus be seen that although zinc is electro-positive to start with, and this is subject to corrosion instead of the structural metals of the condenser or boiler, it becomes in course of time electro-negative when it actually induces corrosion upon the structural parts. The Cumberland system aims at keeping the blocks electro-positive by means of a small low voltage current. They use blocks of iron instead of zinc for this purpose, connecting same through insulated bushings and washers bolted up to the shell to terminal on the outside for applying the battery or generator. The Llanelly Electric Light and Traction Company, who use water up a small estuary from the sea for circulating, have suffered considerably from corrosion. They have put in this system, and find it very efficacious.

The Cumberland people, on examining the faulty tubes submitted by us, recognised the trouble immediately, telling us it was what they termed dezincification.

In the Harris-Anderson system the results obtained are similar, but no outside electro-motive force is applied. It would appear that they alter the composition of the protective metal employed to suit special cases, but the one ordinarily applied is electro-positive to practically all varying alloys of copper and zinc, and is claimed to maintain its protective action until completely eaten away.

The blocks are usually placed inside the water space of the condenser at both ends (the number and size of the blocks depending on the size of condenser), and connected to terminals on the outside and insulated from the condenser casing; such terminals being connected by means of insulated cables to the tube plate at the opposite end of the condenser.

It is essential that the tubes themselves be well electrically connected to the tube plates, and to ensure this metallic washers are fitted. The Harris-nAderson system has been employed by us on the condensers of two 2,000 K.V.A. Turbo Alternators with very marked success. Previous to the installation it was necessary to replace several tubes every few days, sometimes as many as five at a time in less than a week, whereas now it is only an occasional aube every few weeks.

I may say for the information of those adopting this apparatus that it is very essential the right metal be used for the blocks. On one occasion we ran short of these blocks, and, understanding that aluminium was the basis, used aluminium blocks cast locally, but with very poor results.

It has been found very efficacious to occasionally brush the blocks down, and this we do once a week when cleaning out the condenser tubes, which latter practice is necessary with the use of sea water from Table Bay.

The following are a list of Ampere meter readings taken, shewing the current flowing between each block and the tube plate at the opposite end of the condenser on the two condensers in which this apparatus is installed:—

No. 1 CONDENSER.

Front End.

1st circuit	.245 amps.
2nd ,,	.25
3rd ,,	.25
4th ,,	.295

Back End.

1st circuit	.308 amps.
2nd ,,	.217
3rd ,,	.259

No. 2 CONDENSER.

Front End.	
1st circuit	.427 amps.
2nd ,,	.403
3rd ,,	.415
4th ,,	.438
Back End.	
1st circuit	.158 amps.
2nd ,,	.278
3rd ,,	.218
4th ,,	.223

It will be noticed on No. 2 Condenser that the current flowing from the blocks is more at one end than at the other; this is, to my mind, a clear proof that the brushing of the blocks occasionally is very efficacious, as the blocks at back end are more difficult to get at.

With regard to No. 1 Condenser, I should state that the apparatus is not so effective as on No. 2, and one would naturally expect this, as ammeter readings are considerably lower. This matter is now under consideration with the idea of increasing the size of the blocks on this Condenser.

Finally, I might state that this Harris-Anderson system appears to have been used with considerable success by the Cunard Steamship Co., the "Coronia," "Carmania," Mauretania" and the ill-fated "Lusitania" all being fitted with their protective device.

DISCUSSION ON MR. LONG'S PAPER.

Mr. A. S. Munro (Pietermaritzburg) asked "whether with the use of ordinary river water for condensing purposes it would be possible that there might be an electrolytic action on the tubes due to the contact of dissimilar metals used in the manufacture of the condenser"?

Mr. B. Sankey (Port Elizabeth) cited a case where a surface condenser had to be designed to use water from a tidal stream alternatively of sea water and fresh, the corrosive effects of which were anticipated to be more severe than when using sea water only. The tubes were specified to be solid drawn brass tubes, Admiralty mixture, ¾-external diameter, 19 S.W.G. thick. These lasted from three to four years in regular daily service, when the whole of the upper section nearest the exhaust pipe had to be renewed. Mr. Sankey also mentioned the Dionic Water Tester as being of great value in detecting the minutest traces of sea water in the hot well water.

Mr. J. Roberts (Durban): The subject chosen by Mr. Long, though one of considerable importance, is not of any very direct general interest to members, because the particular condenser trouble which he has described and given the remedy for is not one met with except by those who use salt water for condensing purposes, but the subject of condensing is one with many sides. Those in Mr. Long's situation have to deal with the corrosion of tubes by salt water, which is worthy of a special paper to itself, as Mr. Long has given us. The up-country man has to solve the condensing question generally with a very limited water supply available, and in many cases has to resort to cooling towers. Mr. Dobson, in the remarks he made on the paper, expressed surprise that those situated at the coast had not all taken advantage of sea water for their condensers and laid their stations down near the seashore. But, in reply to that, I would point out that in many cases stations were built from ten to fifteen years ago, before turbines were seriously considered, and when the phenomenal increase of electrical output was not foreseen. Under circumstances existing at that time the provision of a vacuum, which is essential nowadays, was not economically necessary, but there is no doubt that the time may come when large electricity works at coastal towns will have to consider making such arrangements as will give them the benefit of an unlimited supply of sea water for their condensers. When that contingency arises then Mr. Long's paper will be most useful for reference, and it is clear that the corrosion due to sea water has lost its terrors.

WEDNESDAY, NOVEMBER 17th, 1915.

The Congress met at 10 a.m. at the Town Hall Mr. Horroll, of Pretoria, and Mr. Proctor, of Boksburg, were present for the first time, and were welcomed by the President and members present.

Mr. John Roberts, City Electrical Engineer of Durban, then read the following paper:—

TARIFFS OF PRICES FOR ELECTRICITY.

The problem of fixing scales of charges for electric current is undoubtedly one of the thorniest which the manager of an electric supply organisation has to tackle. Local conditions frequently make some of his engineering difficulties pretty great, but usually the best solution can be found after proper study and careful judgment, and then the matter is settled once for all; but the tariff question is always with him. A scale of charges which at a particular moment may be correct will be sure to require some revision at no very much later date, due to some new development in demand, or alteration in the costs of production.

The requirements of a proper tariff of charging are mainly three in number:—

1. Not only must the total revenue be sufficient to cover all legitimate charges on the debit side of the account, but each class of supply for which a special charge is made should pay its fair share of the **total** (as distinguished from the working) costs.

2. Consistent with the above, the scales of charges must be such as to encourage the maximum use of current because of the beneficial effect of large output on costs of production per unit.

3. The tariff must be easy of explanation to laymen so as to induce a feeling of confidence among consumers that it is based on an equitable as well as a sound commercial footing. This is particularly necessary when the undertaking is operated by public bodies such as Municipal Councils.

It is greatly on account of the last requirement that the writer has felt impelled to prepare this resume of the subject, in the hope that it may be of some assistance to others in the same position as he is in having to satisfy newly-elected Councillors of the reasons for charging as low as a halfpenny to large consumers and as high as five pence to small lighting consumers.

It is proposed herein to go into the subject as exhaustively as space and time permits, though a complete exposition would call for such numerous references to the views and arguments of engineers that nothing less than a bulky volume would be wanted. A good deal of the matter introduced to explain the points of the problem of charging for electricity will be quite familiar to electric supply engineers, but it is necessary to mention it to make a proper and logical presentation of the subject, especially if it is to be intelligible to non-technical men.

First of all, it may be pointed out that the supply of electricity is not the only business in which great diversities of charges occur. The supply of a commodity or service rendered, in fact in the sale of all classes of commodities, there is, of course, differentiation in favour of the large purchaser—we do not include such articles as postage stamps in such a category. Sugar, for instance, sells in bulk at, say, £20 per ton (a little over 2d. per lb.), and is retailed at 3½d. A carcase of beef weighing 700 lbs. is sold for, say, £1 17s. per 100 lbs. (4½d. per lb.), while butchers' meat retailed averages, say, 9d. Similar cases can be multiplied.

It is somewhat noteworthy, however, that the differences between wholesale and retail prices do not range between such extreme limits as we are accustomed to in the case of electricity tariffs. But if we turn to another sphere of commerce, viz., railways, we find the range of prices enormous. A ton of coal by the truck load is carried from the Transvaal collieries a distance of 1,047 miles to Cape Town for 13/- per ton, equivalent to .17d. per ton per mile, whereas ordinary goods are carried from Durban and Johannesburg, a distance of 480 miles, at the rate of 5/9 per 100 lbs., which is equal to 3d. per ton per mile. Here, now, is an example of as wide a range of charges as hold good for electric current, and it is, perhaps, interesting to examine why the charge to the very large customer of the electric power station and of the railways is as little as one-sixth to one-tenth of the charge to the small consumer for an equal amount of current delivered or material carried, while in the sale of commodities there is not nearly the same difference between the prices charged to the wholesale and to the retail purchasers. The reason is not far to seek, and it is this: that such services as transport of goods and delivery of electricity cannot be compared with the manufacture of a commodity. The cost per lb. of making soap, let us say, is not much different if 1,000 or 100,000 tons are turned out per annum. The material and labour costs per lb. are lower for the larger plant, but not very greatly, whereas in the manufacture of electricity and the carriage of goods the cost of making 100,000 units, or carrying 100,000 tons, might be only one-tenth of the amount per unit, or per ton, of the cost per unit of making 1,000 units, or carrying 1,000 tons.

It is curious that the manufacture of current and the transport of goods should bear this striking resemblance. It seems to the writer that the reason is that, though the two services seem dissimilar at first sight, they bear this likeness that the commodity they supply is not a physical one. It is, as a matter of fact, energy—the energy of motion. In the one case goods are transported. In the other, electricity is circulated. The motive power in one case is the steam locomotive; in the other it is the dynamo driven by the steam turbine. In the one case the goods transported are the railway wagons; in the other the material moved is electricity. The wagons are carried over railway lines; electricity is carried over wires. It follows that both businesses will have the same outstanding characteristic, which is, that in the cost of working the standing charges consisting of salaries, wages, interest on capital and depreciation on plant is very high compared with the charges which vary according to the volume of its business such as consumable materials and upkeep of plant. It is also significant to note that the heaviest item of consumable material is the same in both cases, being fuel. The above comparison, though not strictly germane to a discussion of electric current charges, is made to show that the lectric supply business is not peculiar in the extreme diversity of the charges made to its respective classes of consumers. And the point is specially referred to because we municipal electrical engineers, being in most cases pioneers in a new field, have to do a good deal of missionary work. We are for the first time developing a new power, and the conditions are so different to most of the other well established businesses that we have to educate not only those whose needs we are catering for, but those who are placed in charge of our departments by the burgesses—I mean the members of our Committees and Town Councils. Some day or other the business of electric supply will be reduced to standard lines, not only in regard to its engineering, but its commercial features, and it will not be left to each individual manager to devise his own tariffs in order to meet his local conditions and develop his supply to its fullest, but that time is not yet. We are all more or less breaking new ground, and, though pursuing the same objects, are not all following similar paths. Some of us are not even in close agreement as to our objects, or, at any rate, some of us may think some of those objects, though ultimately to be gained, are not yet quite in the sphere of practical politics at the present time. But, at any rate, we are all learning from our own successes and mistakes, and from the results obtained by each other, and before I go back to my immediate subject again I cannot refrain while in this connection from saying that the municipal electrical engineer who has kept his end up this past fifteen years or so—who has kept up to the minute in his aims and methods—has had a pretty rough row to hoe. He has had to educate a public slow to take advantage of new methods, to persuade Councillors that he is not going to ruin the town, and to keep pace with an art of which the instruments, appliances and machinery have been constantly changing. He has had to have the judgment of a Daniel to choose between all the rival systems which have been put before him, and especially in this country, so far from the seat of manufacturers, he has had to get out of his own difficulties as best he can without anyone in his neighbourhood to help him. And all that in a business which, under the most favourable conditions, is essentially a trying and difficult one, calling for ceaseless diligence and the utmost resource.

My business in this paper is to point out some of the conditions which have to guide one in the selection of a tariff for current which will meet the three conditions I have already set out:—

1. Commercial soundness.
2. Fairness and equity.
3. Simplicity.

The three conditions are so intermixed in the argument that I shall not try to keep them separate. As it will be necessary to use figures to a very large extent, I propose to give, as a concrete illustration of the reasoning, the figures now relating to the Durban Municipal undertaking, as I think they will be specially useful and interesting because of the large number of scales for current which are now in force. These scales cover wide ranges, viz., from ½d. to 5½d., and first of all I will give a short statement of the various scale of charges now in force:—

1. A flat rate of 5½d. per unit, less 10 per cent. for cash in seven days, subject to a minimum charge for business premises of 5/- per month, but with no minimum to private householders.
2. To business premises keeping open after 5 p.m., a second meter and time switch is installed on application, which allows current to be bought for:

   5½d. between 5 p.m. and 12 midnight;
   1d. at all other hours.
3. To business premises closing at 5 p.m. (and who, therefore, use very little current at 5½d.), the charges by second meter and time switch are:

   5½d. between 5 p.m. and midnight;
   2d. at all other hours.
4. To domestic consumers only (alternative at consumers' option to Scale 1), a minimum sum per month depending on rateable value of house (not including land) entitling consumer to the corresponding units at 5½d. per unit (all less 10 per cent. for cash in seven days).

EXAMPLES.

Valuation.	Minimum Charge.	Units at 5½d.
£200	4/-	9
£600	9/6	21
£1,000	13/-	28
£1,600	16/-	35

(It is probably correct to say that the average seven-roomed house in Durban is valued at from £800 to £1,000.)

5. For current used for **motive power:—**

First 100 units per month	2d. per unit
Next 200 "	1¾d. "
" 1,200 "	1½d. "
" 8,500 "	1d. "
" 5,000 "	¾d. "
All over this amount	½d. "

Subject to a minimum charge equal to £3 per annum of the maximum H.P. demanded up to 20 H.P. (The highest minimum charge is therefore £60 per annum.)

6. For **Heating and Cooking** purposes in boarding houses, hotels, restaurants, etc., special heating circuits must be installed, and through these circuits the current is sold at ¾d. per unit.

NOTE.—All the above tariffs, whether specially mentioned or not, are subject to a cash discount of 10 per cent.

Supply to Tramways.—1d. per unit at the feeder panels at the power station.

Bulk Supply to Government.—¾d. per unit for 6,600 volt three phase current, plus 10 per cent. for direct current.

(There are a few other special tariffs, but they are of no particular interest, being to meet special cases such as out-of-the-Borough customers, who are, on general principles, supplied at less favourable rates than those in the town.)

In this paper I shall endeavour to show that these rates are, in general, fair and equitable, and have resulted in a good demand for electricity, and first of all I give a statement of the amount of current sold for various purposes:—

For Lighting and Heating (private consumers)—		
At 5½d., 1,958,958 units.		
At 2d., 150,201 "		
At 1d., 172,381 "		
At ⅝d., 689,644 "		
	2,971,184	£44,883
For power (private consumers)	4,116,044	16,983
" Government Contract Supply	3,307,927	11,165
" Tramways Supply	3,744,880	15,603
" Street Lighting (inclusive of attendance on lamps)	901,165	7,119
" Lighting to Corporation Departments	217,294	3,607
" special bulk supply (private consumers)	1,564,130	2,190
" Power to Corporation Departments	837,298	2,985
	17,659,922	£104,538

The above revenue may be classified as follows:—

	Units.	Revenue.	Per Unit.
Tramways	3,744,880	£15,603	1d.
Street Lighting	901,165	7,119	1.9d.
Motive Power	9,825,399	33,323	.81d.
Lighting and Heating	3,188,478	48,490	3.66d.
	17,659,922	£104,658	1.42d.

This classification is made under the above four heads because these latter represent the principal classes of supply, and I shall endeavour now to show from ascertained figures of working cost and capital expenses what the actual cost of each service is to the department.

It is necessary, first of all, to point out what is well known to electrical engineers, that charges are as important as working expenses, and we must therefore apportion out as nearly as we can the share of both these items among the four classes of supply we are examining. It is fortunate that in the Durban system the distribution of lighting and heating is carried out almost entirely by means of its own system of both high and low tension single phase mains; the tramways are supplied through their own feeders; motive power is taken care of by means of a special 500 volt D.C. distribution, and a three phase system reserved almost entirely for power supply. The street lighting has also a special network, though this is fed from the low tension system of the ordinary lighting network. It is, therefore, possible to arrive at the cost of distributing the various services separately, and it happens that in Durban a valuation of the whole of the plant has recently been made, and from this valuation the cost can readily be apportioned. There is still, however, the cost of the Power Station and its machinery which must be allocated, and such allocation cannot be done in the same way as in the case of the distribution system. The same dynamos and alternators are used indiscriminately for lighting and power, etc., and I have used the maximum demand of each service as the criterion on which the capital expense of the various services should be allocated, as shown in the following table:—

Service.	Max. Demand.	Units.	Load Factor.	Cost of Plant.
Tramways	1,780	3,744,880	24%	£44,900
Street Lighting	220	901,165	43%	5,550
Motive Power..	2,800	9,825,399	40%	70,500
Light and Heating	1,894	3,188,478	19%	47,788
	4,300	17,659,922	47%	£168,738

(It is scarcely necessary to point out that the total maximum load is not the arithmetic sum of the individual maximum demands. It is worth noting that the load factor is the yearly selling load factor. The total selling load factor of 47 per cent. is more favourable than would seem at first sight, because, of course, a load factor of 100 per cent. based on units **sold** cannot be realised in any plant unless current is sold at the switchboard. A selling load factor not only takes note of the diversity of the load, but the losses in distribution as well.)

Using the above allocation of capital expenses on the Power Station Plant on the basis of maximum demand, the allocation of the total capital expenditure is as set out in the following schedule:—

CAPITAL EXPENDITURE.

On Tramway Supply..	£65,580
On Street Lighting	23,150
On Motive Power Supply	129,500
On Private Light and Heat	181,770
Total Capital Expenditure	£400,000

It must be remarked that while the allocation arrived at in the above is reasonably accurate, it is quite impossible to arrive at more than what may be called a close approximation.

A sub-station, for instance, will be used for private lighting, power, and street lighting switching. Certain mains are also used for all three services, but on account of the special conditions of the supply, as explained in the foregoing, the division of capital expenditure is probably easier in Durban than in most other systems. We are now able, therefore, to allot to allot capital charges, which will be done in the proper place.

Turning now to Working Expenses, these are divided up in the Durban Expenditure Accounts under the following heads:—

Generation.
Distribution—Overhead Mains Maintenance.
Underground Mains Maintenance.
Sub-stations.
House Services—Meter Reading and Meter Repairs, etc.
Street Lighting—Repairs and attendance on street lamps.
Salaries—Including locomotion, etc.
Sundries—(Rates, Rents, Town Treasurer and Town Clerk, etc.)

In the case of **Generation** the allocation we are arriving at is made on the basis of the number of units supplied. (It is not necessary for determining purely working costs to take load factor into account.) The allocation is not strictly correct. For instance, the single phase lighting and heating supply being at practically 100 per cent. power factor is more favourable than the three phase power service, which sometimes drops as low as 75 per cent. But we do not enter into refinements of this kind. There is, however, one point which must not be lost sight of, and that is the difference between the cost of generation of the unit at the switchboard and the same cost per unit sold, for the difference is in some supplies much greater than others. Taking the Tramway Supply, there is no difference at all, because current is measured in the Power Station, and the Tramway Department bear the cost of all the loss in transmission on feeders and return circuits. The same remarks apply to street lighting current, because the units calculated as used in street lamps take note of losses in mains. The losses in motive power supply from the D.C. mains are in the neighbourhood of 7½ per cent., while on the Bulk Supply at 6,600 volts they do not average more than 3 per cent. to 4 per cent. On the lighting and heating supply, however, the losses are of an entirely higher order. There are losses in high tension, low tension mains, transformers and meters. The last two are, of course, independent of the load, and as the load factor is poor, and consequently the size of transformers are high in proportion to the current sold, the transformer losses will also be abnormally heavy. Further, the number of transformer feeding points on a scattered residential network is also high, which means that the capacity of the individual transformers is much above the maximum load on them. In the Durban system there are no less than 89 transforming points, and the total single phase transformer capacity is 4,040 kilowatts. It may be interesting to give a rough approximation of the losses which occur on our scattered single phase lighting and heating supply:—

Transformers.	Units.
4,040 k/w—iron loss (say) ¾ % for 365 days. (30.3 k/w) .. .. =	266,000
Meters.	
6,800 meters—1.4 watts average loss in shunt (9.5 k/w) .. .. =	87,000
C^2 R. Losses.	
Assuming a loss at full load of 10 % in high and low tension mains and transformers—686 k/w hours per day .. .. =	251,000
	604,000

This loss is somewhat higher than the figures obtained from actual results, but it shows that a scattered supply over a wide area involves heavy unavoidable distribution losses.

Turning now to the allocation of generating costs in the light of the above, the method I have adopted is to arrive at a figure of works cost per unit as the switchboard common to all classes of service. This figure for the year ending 31st July, 1915, being .366d. Tramway, as well as street lighting current lighting, is the same per unit sold for the reasons mentioned, but the figure for motive power per unit sold is .388d., and for lighting and heating it is .425d. on account of the losses in distribution.

The **Distribution Expenditure** can be fairly easily divided up. Overhead mains maintenance, for instance, is incurred almost entirely on the lighting and heating supply. **House Services** are incurred entirely on lighting and heating and motive power, the far greater proportion being involved in lighting and heating, there being 7,000 consumers concerned against only about 350 for power. **Street Lighting** expenses are, of course, all charged up direct to this service.

Some discrimination is wanted in the allocation of the items of **Salaries** and **Sundries,** and, of course, differences of opinion are likely to occur in this connection.

In the light of the above, the allocation of working expenses and capital charges are made in the Schedule marked Table 2. The item of Borough Fund Contribution calls for a word of explanation. It is the charge made on the department in favour of the general funds of the town in aid of rates, and amounts to 4 per cent. on the total loan funds of the undertaking. These funds amounts to £415,000. The contribution levied on the department last year, it will be observed, was £17,336. Four per cent. on £415,000 is £16,600; the difference is accounted for by the fact that the undertaking has contributed out of preceding years' profits the sum of £33,000 towards capital expenditure, and this amount is added to the loan liability for the purpose of calculating the contribution in relief of rates. For the purpose of this examination into charges for electricity, the contribution towards rates will be disregarded, as it is not a legitimate expense charge, being, of course, a surplus yielded as a profit earned by the undertaking.

The following tabulation is a Summary of the results arrived at in the Schedule:—

	Total Supply.	Tram-ways.	Street Lighting.	Motive Power.	Light & Heating.
Working Expenses ..	£48,522	£7,570	£3,891	£20,670	£16,387
Capital Charges ..	31,938	5.253	1,837	10,212	14,636
Total Expenses ..	80,460	12,823	5,728	30,882	31,023
Revenue	104,658	15,603	7,119	33,323	48,490
Surplus	24,198	2,780	1,391	2,441	17,467
Working Expenses, p. unit	.66d	.48d	1.07d	.503d	1.23d
Capital Expenses, ,,	.434d	.336d	.49d	.246d	1.10d
Total Expenses, ,,	1.09d	.82d	1.56d	.750d	2.33d
Revenue, ,,	1.39d	1d	1.92d	.81d	3.64d

Remembering that we have taken no account of the contribution in aid of rates, it is clear from the above that all the various classes of service are providing a surplus, and we can now see whether the tariff in force in Durban is complying gwith the three conditions which we set out by saying that every properly devised scheme of charges should comply with:—

1. **Commercial Soundness.**—The charges are evidently commercially sound, no loss is incurred by any of the services, and the growth in the demand proves that the use of electricity is being encouraged.

2. **Fairness and Equity.**—No complaints can be made on these grounds; all charges on the whole are low. The criticism which, however, might be made is that the consumer of light and heat is

contributing an undue share of the profit. In reply to this, however, it has to be said that for purely lighting current 5½d., less 10 per cent., cannot be said to be a high charge, and in the second place it has to be said that the consumption of heating units is increasing at a great rate, and the average charge yielded by the domestic consumer is rapidly falling.

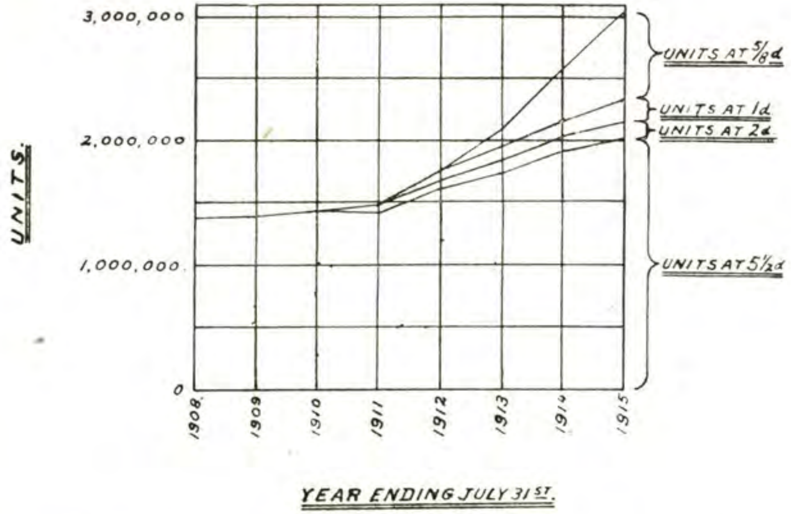
3. **Simplicity.**—The tariff is **simple,** and no lengthy explanations are required in putting the different tariffs before the consumer.

A few remarks on some of the tariffs themselves may be of interest, and I commence with the domestic charge, which has been devised for the encouragement of electric heating and cooking. Attempts have been made for many years past to induce lighting consumers to take up electric heating. The first thing in the way of a special tariff was by means of two meters and a time-switch. It was felt that the cooking load could not be encouraged if it increased the lighting peak, so cheap current was not given after 5 p.m. It was hoped that consumers would go in largely for small appliances such as kettles, irons, grills, toasters, hot-plates, etc., which would be used in the daytime and so save the kitchen fire till the evening meal, which is generally the principal one of the day in this country. But the scheme did very little towards achieving the end in view, and practically nothing but kettles and irons were installed. It was evident that for electric heating to be successful there must be no restriction as to hours, and a local adoption of the "Norwich" system was decided upon. That system, which was the pioneer in methods of charging within the past few years, and was a worthy successor of the illustrious "Maximum Demand" system of Wright of the nineties. It has the immense advantage over its predecessor, however, in its simplicity. The Wright system was a stroke of genius in the manner in which the correct principles of charging for current were first embodied, but the practical difficulties of using it with a large and non-technical class proved too much for it, and after a period of meteoric success it has now sunk practically into oblivion. The "Norwich" system substituted as a basis for the initial charge whose function is to cover capital and standing charges the rental value of the premises; of course as a scientific measure of these charges there is nothing to recommend it but its simplicity. Two houses with the same rental value may cause greatly different standing demands on the supply, but the system of basing the maximum charge on the rental is one that bears on the consumer with some discrimination as to his capacity to pay (which has a good deal to commend it), and the laziest consumer can grasp the idea without any trouble. The advantage to the supply authority is that no change has to be made in the service arrangements, nothing more than the usual meter being required. In Durban it was almost impossible to fix the rental as the basis. Rents vary according to the neighbourhood or according to the size of land, etc., factors which have nothing to do with the size of the dwelling. Further, a great many people live in their own property, and rental value is not the criterion for rates as it is in England. The freehold valuation forms the basis of municipal taxation in Durban, as it is, I believe, in most other South

African towns. This basis was chosen, therefore, as the one upon which to fix minimum charges. These charges vary from 4/- per month for a house (without the ground), valued at £200, up to 25/- for a value of £4,800. A curve is appended which shows how the sale of cheap current to the lighting consumer as a direct result of this tariff:—

CHART SHOWING GROWTH OF CHEAP RATE UNITS FOR DOMESTIC AND HEATING SUPPLY (NOT POWER).

(PRICES ARE LESS 10% DISCOUNT).



A word as to the charges to hotels, restaurants, etc., may be of interest. When the valuation system was introduced for private consumers, an examination of the values of hotel and restaurant properties was also made, but the figures showed such extraordinary divergencies with no apparent relation whatever to the amount of electricity consumed that it was evident that as a basis for fixing electric standing charges, the value of the property was useless. On any reasonable scale which could have been chosen, some consumers' minimum would have only been a quarter of their usual bill, while others would have had to pay two or three times as much as they were accustomed to pay before they could have got the benefit of the cheap rate. There was no option, therefore, but to require consumers who wished for heating current to instal a completely separate circuit and to measure this consumption through a separate meter.

There are obvious disadvantages. There is the expense of the special circuit, and then there is the danger of the consumer accidentally, or by design, using the circuit for lighting purposes. In order to distinguish it as much as possible all heating mains haae to be run in screwed steel tubing, whereas lighting wires are usually enclosed in simplex.

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 direct current systems had better leave it alone, or else get changed over to A.C. as soon as possible. It would be a pity to relinquish this branch of possible revenue and to have to make the admission that the field is beyond the region of electricity's possibilities. From the experience in Durban, and leaving out for the moment the mains problem, I am satisfied that electric heating can now do at least as well as gas, and when some more improvements are made in appliances will beat gas hollow. I am also satisfied that efficient plants can sell current profitably at rates for heating low enough to create a good demand from consumers. But the mains question has to be tackled seriously. The difficulties, however, with A.C. systems are not insuperable In Durban we have the usual comparatively sparsely populated residential district and use overhead mains, three 19/16 conductors being our standard, with 400 volts across outers. The high tension mains are in nearly all cases laid underground, and it is our practice to drop in transformers at new feeding points as the load increases. When the new tariff was put into force the whole residential district was re-surveyed from the distribution point of view, and thirty or more new transformer pits were built at likely spots and new high tension feeder routes arranged to pass these points so as to be ready to deliver current to the network wherever the additional cooking load was causing undue drop. There are now as many as 89 transforming points in the town, and the consequence is that the outlay on low tension mains is not heavy and pressure throughout the area is good. I realise that in the residential parts where the cooking load is growing still more of these transforming points must be put in. I think these are the right lines to go on. It involves certainly a few more transformers than what would be wanted if the transforming points were more centralised, but one must have the transformers somewhere, and a transformer by a reputable maker is an extremely reliable piece of plant. The system also requires a rather extensive system of H.T. feeders. In fact, it soon becomes a system of distributors as well as feeders, but even here there is little trouble. An armoured concentric cable for 2,500 volts carefully jointed and laid well out of harm's way seldom fails.

As to the commercial soundness of a charge as low as ⅝d., less 10 per cent., which is .56d., well, the figures of our revenue and working costs seem to prove that we are on the right side. Of course I realise that the average price from the lighting and heating consumer, now standing at 3.6d., will begin to fall rapidly, as the number of ⅝ units increase, but our total expenses, including capital, are only 2.33d., and it must not be forgotten that working expenses also decrease at a great rate as the output increases.

In this connection I feel I have not laid as great stress on the matter of reduction of total costs per unit with increase of output probably because I felt that the reason for it is so well known to electrical engineers, this reason being that the standing charges, which do not increase much with output, are so much greater than the costs, which vary with the load. Of course we have to bear in mind that increase of output is not of great value without improvement in load factor, but it is just improvement in load factor which cheap units mean to us. Another important thing to bear in mind is that great efforts must be made to keep down the coal figure. Of course with poor load factor the cost of coal is not a large proportion of the working expenses, but as load factor improves, this item begins to have a greater and greater effect on costs, and one knows that every unit generated means a definite quantity of coal, and this figure fixes the ultimate moderation of charges, and if it is a high one quite debars selling current for certain purposes for which a low tariff is essential if the business is to be secured at all. It must also not be forgotten that every additional unit sold puts the undertaking in a better position to sell another, for the operation of supply and demand in the business of electricity production works in the exactly opposite way to the " vicious circle," we must coin a new term and call it the " beneficient circle." The more you sell, the cheaper you can sell it, and the cheaper you sell it, the greater will be the demand, and so on "ad infinitum" almost. **Almost,** for the curve will be an asymptote to the coal line.

I append as perhaps of some interest two charts, one showing progress in output, working costs, etc., of the Durban system since 1905, the other showing the reductions made in revenue and working costs per unit.

I would like to make a few remarks in conclusion on the matter of tariffs for electricity generally. As I remarked at the outset of this paper, the fixing of tariffs for current is perhaps the most difficult task of the electric supply engineer. We have to continually cater for special cases, each of which seems to require a special rate if the business is to be secured, as no existing scale is applicable, and so special terms have to be offered. The rock to be avoided is, of course, business which is not profitable, but we have always to bear one important factor in mind, and that is that in making a bid for a new demand a rate which may not be payable at first will yield a handsome return when a large output has been cultivated. Take the heating business, for instance. A station with only a lighting demand must have comparatively high working expenses, say 1d. per unit. If this figure is taken as the lowest at which current can be offered for cooking purposes, then no considerable increase in output can ever be expected, but if, say, a halfpenny is fixed as the charge, then a large output will soon be secured and the working expenses may be reduced to such a figure that the new rate is quite profitable.

The next point in these concluding general remarks is that one should never forget that the old "Wright" system, though now abandoned so far

TABLE 2.—— SHOWING COST OF VARIOUS CLASSES OF CURRENT SUPPLY.

TOTAL:-				TRAMWAYS.			STREET LIGHTING.			MOTIVE POWER			PRIVATE LIGHTING.		
CAPITAL EXPENDITURE.	400.000			65.580			23.150			123.500			181,770		
UNITS GENERATED.	18.775,813.			3,744,880.			901,165.			10.434,768.			3,695,000.		
UNITS SOLD	17,659,922.			3.744,880			901,165			9.825,399			3,188,478		
	Total Cost	Average per unit		Total Cost	Per unit.		Total Cost	Per unit.		Total Cost	Per unit		Total Cost	Per unit	
COST OF PRODUCTION —		Generated	Sold		Generated	Sold		Generated	Sold		Generated	Sold		Generated	Sold
Generation	28.670	366d	·388d	5,720.	366d	366d	1.376	366d	366d	15,920	366d	388d	5.654.	366d	425d
Overhead Mains Attendance	1,423		·020				300		·08	200		005	923		·069
Underground - Substations	790		·011	100.		006	100		027	200		005	390		·028
House Services.	3,202		·042							600		015	2,602		195
Salaries, Militia pay etc	7,915		·108	1,000.		064	500		·133	2,000		049	4,415.		332
Attendance on street lamps	1,215		·016				1,215		322						
Sundries (rents rates, etc)	5,303		·072	750.		·048	400		·106	1,750.		·042	2,403		·181
Total Working Cost	48.522		·66d	7,570.		·48d	3,891		1·03d	20,670.		·503d	16,387		1·23d
CAPITAL CHARGES —															
Interest etc.	16,371.		·22	2.680.		·171	949.		·252	5,300.		·129	7.442		·552
Renewals.	12.778		·17	2,095		·134	740		·195.	4,140		·101	5,803		·436
Sinking Fund	2,789.		·04	457		029.	161		·043	903		·022	1,268		·095
Total Capital Charges.	31,938.		·434d	5,232		335d	1,850		·49d	10,343		252d	14,513		1·09d
TOTAL COST	80,460.		1·09d	12,802		82d	5,741.		1·53d	31,013.		76d	30,900		2·32d
NET SURPLUS	24.198			2,801.		·18d	1,378		·37d	2.310		056d	17,590		1·32d
BORO' FUND CONTRIBUTION	17.336.		·236d	2,860.		·18d	1,005		27d	5,620		137d	7,851		59d
TOTAL.	97,736.		1·33d	15,662.		1d	6,746		1·8d	36,633		835d	38,751		2·92d
RECEIVED	104,658		1·39d	15,603		1d	7,119.		1·9d	33,323		813d	48,490		3·65d
Surplus or Deficiency.	6,862. Surplus			59. Deficiency			373. Surplus.			3,310. Deficiency			9,739 Surplus		

as its detail is concerned, embodied the only true principal of charging for current, and one which we should one day try to achieve in actual practice, and that is that every consumer, be he a private householder, a hotel or restaurant keeper, a shopkeeper or a manufacturer, should pay his proper share of capital expenses as a standing charge, and then pay for all current he uses at a figure fixed to yield a small return on the working cost of delivering the current to him. At present it seems we are unable to arrive at a simple method of allocating standing charges to meet such varying conditions as present themselves, and consequently some of our tariffs are more or less haphazard, and probably result in some paying less and some more than their fair share. But though a counsel of perfection, it is one which we should aim to follow more or less strictly one day. Then the small householder wanting light and heat would pay us, say, 7/6 per month as a standing charge and ¾. for all current he consumes, and the large power user would give us, say, £1,000 a year minimum and ½d. for current. Everyone would then be treated alike, and each would be satisfied that he was not paying more than he ought; we should secure that every consumer was a profitable one to the supply, and we should then be selling at rates attractive enough to yield the maximum output the area could absorb.

I must apologise for this somewhat incomplete presentation of a difficult and complicated question, and I hope that any benefit which may be derived will follow from the discussion which I hope members will be induced to contribute.

An interesting discussion followed, in which the majority of members took part, but owing to pressure of time it was decided to adjourn and to continue the discussion at the next opportunity, the President undertaking to prepare his contribution to the discussion in the meantime.

The thanks of the meeting to Mr. Roberts for his paper were proposed by the President and seconded by Mr. Long.

(NOTE.—Owing to the pressure of business matters it was found impossible during the remainder of the week to give Mr. Roberts' paper the time required for a full and exhaustive discussion, and it was decided, in view of the importance of the subject and the general desire to study the questions raised more thoroughly in detail, that this paper should be taken again at the next Congress and opportunity given for a full discussion.)

The delegates left the Town Hall at 12 noon in motor cars kindly placed at their disposal for the Randfontein Estates Gold Mining Co.'s Power Station, lunching on the way at the Grand Hotel, Krugersdorp, by the kind invitation of Hubert Davies, Esq.

The party arrived at the Power Station, Randfontein, at 2.30 p.m., and were welcomed by Mr. T. E. P. Butt, Consulting Electrical Engineer to the Company.

The visitors were conducted round the whole of the plant in detail by Mr. Butt and his staff, and left at 5 p.m., having enjoyed a most instructive and interesting visit.

POWER STATION.

Total Station Capacity:—26,000 K.W.
Sub-Stations:—11 in number. Total Capacity:—37,000 K.V.A.
Transmission Cable:—45 miles approximately.
System:—Three phase. Voltage:—6,600. Frequency 50.

PRINCIPAL DETAILS.

Turbo Generators.—3—6,000 K.W., 3—2,000 K.W., 2—1,000 K.W. Type: Parsons and Westinghouse.

Switchgear.—Electrically and also mechanically operated remote control Westinghouse Type.

Boilers.—24 units in banks of 4.

Heating surface	4,780 sq. ft.
Grate Area	120 sq. ft.
Superheater	900 sq. ft.
Economiser	3,200 sq. ft. per two boilers.

Each boiler capable of providing 14,000 lbs. of steam per hour at a pressure of 160 lbs. per sq. in., and superheated to 500 degrees Fahr.

Transformers.—Standard Units of 500 K.V.A. Single phase, oil-cooled, operated in banks of 3 delta-delta connected. Primary Volts 6,600 with tappings for 6,450 and 6,300. Secondary 2,200 and 500 Volts.

Cables.—3-core paper insulated, lead sheathed and steel armoured, laid direct in ground. Working voltage 6,600.

Cooling System.—1 — Enclosed, natural draught tower, capacity 1,000,000 gallons per hour.

1 — Open Tower, capacity 600,000 gallons per hour.

1 — Spray System Reservoir, capacity 1,000,000 gallons per hour.

Coal Bunkers.—Total Capacity 3,200 tons. Extra bunkers 1,800 tons. Interior bunkers 440 tons. Present daily consumption: 400 tons per day (approx.), seven days per week.

Works Cost.—Maximum .2181, minimum .1904 for 1915. Average for 9 months .2039, including all charges, with the exception of interest and redemption of Capital.

THURSDAY, NOVEMBER 18th, 1915.

The Congress met at the Town Hall at 10 a.m. Mr. Ward, City Electrical Engineer of Newcastle, was present for the first time, and was heartily welcomed by the President and members.

Mr. Bellad-Ellis, City Electrical Engineer of Queenstown, then read the following paper:—

DIESEL ENGINES AND LIQUID FUELS.

Some time ago I received an invitation from Professor J. H. Dobson to give a paper on Diesel Engines at this Congress. The request caused me no little surprise when I considered the splendid abilities possessed by South African Engineers generally (but more particularly on the Rand) who are noted in Europe for the magnitude of the undertakings for which they are responsible; in fact, the Rand is undoubtedly the greatest electrical centre in the world, with, I believe, Newcastle (England) as a fair second. This, however, is beside the subject, except to show that it was with considerable diffidence I, as a small member of this great community, undertook to tackle the subject, when I remembered it was to be preached (so to speak) before and to the leading lights in Mechanical and Electrical Engineering in South Africa. Keeping this in view, there is nevertheless no doubt in my mind that when big minds are occupied designing and carrying out big schemes, it is more than likely that the great possibilities and advantages of this particular class of engine may be overlooked.

It has within recent years (in South Africa at all events) been a somewhat troublesome problem to find financial ways and means for the extension of existing schemes. These may take the form of long lengths of expensive cables from high tension sources to supply power and lighting through static or rotary transformers over considerable distances, and I am bold enough to declare that in some instances at least these enormous expenses could be considerably reduced by a consideration and adoption of the Diesel engine as a prime mover fixed upon a suitable site within the area to be developed. In making this statement I do not mean to say that the Diesel engine should be the last word in any such area to be supplied with power and light, but as a temporary measure, pending the full development of a district to such a time as the output would warrant the extension of the aforementioned expensive high tension cables, etc.; in brief, to use the Diesel engine of moderate H.P. to develop an area, during the whole of which time a surplus revenue could be relied upon in the first year, in place of waiting possibly for years for the revenue to cover the interest on capital charges.

Before touching on the practical running of Diesel engines, I will give you a striking example of what can be done and the actual experience of a South African Municipality situated 150 miles from the coast now using three only 100 B.H.P. Diesel engines.

The total capital cost was £12,800, including two only of the abovementioned engines, 63 K.W. direct coupled to 460 volt generators, together with the usual Balancer, Booster, Battery, Switchboard, and outside overhead and underground work, street area say 18½ miles, quite a modest little scheme; and yet although the scheme commenced with street lighting only, and during gthe first twelve months gradually added 400 consumers, it nevertheless made a surplus of £480 in this first year after allowing 6 per cent. interest on capital, 1 per cent. Sinking Fund, and 2¾ per cent. depreciation all round.

I would here like to mention that in commencing this paper I had in mind small areas in round and about large cities like Johannesburg and Cape Town over a radius of, say, five to twenty miles, where similar plants could be made a success, keeping in mind the ultimate possibility of linking up to the central or main supply when the load warranted the change.

The foregoing expereience, I think, speaks for itself, and should give engineers confidence in the low running costs of these engines.

This paper is not meant to advertise any particular scheme or maker of Diesel engine; in fact, the efficiencies of Diesel engines are very much the same, provided they are made by a reliable maker, and if I now show you what can be done by a small staff of moderate-paid men, it will help to emphasise the economical possibilities of these engines. For instance, at one town in the Eastern Province there is a Manager who is also an Engineer, an Assistant who is a Mechanic, an Engine Attendant and a Switchboard Attendant—four men in all—who carry out the whole duties, and have maintained an uninterrupted supply day and night for three years without any hitch or breakdown whatever. This is done quite easily and without undue strain upon anyone (except perhaps the Manager, who sometimes takes a shift and has somewhat longer hours than his staff). But to resume. Until quite recently no member of this staff had put in more than 48½ hours per week, and the station could in addition have doubled its day load with the additional cost of fuel oil and a small quantity of lubricant; and again, although only in its third year, a third engine has been added to cope with the increasing load. This engine was erected by the resident staff—no expensive travelling expenses bringing out erectors from Europe was necessary. This is a most important point, and this by reason of the simplicity of erection and the excellent drawings supplied by the makers; indeed, there has been quite an air of mystery when imported erectors have been on the job, which is, after all, so much bunkum, and tends to make engineers shy of adopting this engine for fear of some great intricacies or unlooked-for faulty development. There is absolutely no necessity for any such qualms of conscience when contemplating the introduction of this engine into any scheme, because a good fitter can easily carry out the erection by paying strict attention to his working instructions supplied by the makers.

With regard to the working principles and efficiencies of Diesel engines, I feel it is almost presumption to give this influential gathering of Engineers any information on the subject, as most of you must be conversant with the working principles of a Diesel engine, but for those who have not had an opportunity of studying the subject, I will now proceed by giving you some of the efficiencies obtainable with Diesel engines as a prime mover, and also any tips and running experiences which are the result of close contact with these engines since their advent in 1908 into South Africa, together with a study of fuel oils (a most important matter in connection with Diesel engines, and indeed with Engineers generally in steam-driven stations). The question of fuel oils will be dealt with later.

These engines were first introduced into South Africa for power-station use at Uitenhage, and because it was, so to speak, a dive into the unknown for South Africa, it received opposition from the Government Department at that time controlling these matters—(this is a long story and very interesting, but is too long to introduce here). However, we ultimately persuaded the powers that be to allow the experiment, with the result that there are now—as you may know—about thirty engines of this type in daily use in South Africa, and prejudice, therefore, appears to be dying down.

I will first deal with the advantages, practical running and operation of these engines, and afterwards touch upon the fuel question and the technical side.

Among the foremost advantages obtained with this type of engine are reliability, accessibility, easy starting, low running costs, ease of operation, low costs for repair, no stand-by losses, great stregnth and liberality of materials used in construction, and, most important of all, its ability to use almost any grade and gravity of liquid fuel (even tar), and also lubricating oil, without any readjustment of the valves.

We will take reliability first. Provided a suitable man is employed (not necessarily a man from the maker's works), you may have no fear of a Diesel engine letting you in, and as the strongest evidence of this I may mention that out of thirty Diesel engines at present in use in South Africa, and since their introduction at Uitenhage in 1908, there has not been a breakdown of any serious description, although the two original erectors have long since left this country, and I am in doubt whether any firm of Diesel engine makers have an erector resident in South Africa, and so far as my experience goes there is no necessity for probable users going to the great expense of getting erectors out from Europe, as already mentioned in my opening remarks. A further evidence of their reliability is the fact that since October 15th, 1912, two of these engines of 100 B.H.P. each have been running alternate days for eight to twelve hours per day, and have always been ready to take up their load, and a failure of the service has still to be recorded, the mains being alive for every twenty-four hours during that period. There does not appear to be anything of an experimental nature about this performance, and it speaks volumes for their great reliability, which immediately brings me to their

Accessibility.

It must be obvious that to maintain an uninterrupted supply for over three years with two engines running alternate days that the only time available for repairs or adjustments, changing of valves, etc., would be the intermediate day whilst a set was at rest. This period has been found sufficient to make all repairs, even to scraping in of main bearings and the periodical necessity of dismantling the air compressors; all these matters have been comfortably dealt with in the time available.

The changing of fuel valves, exhaust valves, inlet valves, etc., are all very simple matters, although the final adjustments, which mean very fine clearances to several thousandths of an inch, take some little time and care. This is where a careful Engineer comes in, and is the very essence of good and smooth running; however, with constant practice this becomes quite easy.

Fuel pumps are used by all makers of the Diesel for forcing fuel oil into the vicinity of a fuel inlet valve of each cylinder when a pressure of air is admitted at the right moment to force this charge of oil into the cylinder at the moment of highest compression. These pumps and fuel valves are somewhat complicated, but on account of their accessibility are easily adjusted, and require only the ordinary experience of the average fitter.

Starting.

The method of starting requires careful consideration for the beginner, but, like everything else, becomes second nature when the engine has been in use some time, the whole operation from the time of turning on your fuel oil to putting a full load on to an engine requires only 60 to 90 seconds; it can in cases of emergency be done much quicker than this, even as low as 30 to 40 seconds, and this without any preparation whatever, the engine being always ready to take its load, because you have no heating apparatus or other auxiliary means of assisting vaporization, all of which take up the time in any other type of internal combustion engine, and build up stand-by losses.

Strength of Materials.

It must be quite evident that the expansion stresses are great owing to the rapidity with which heat is generated and a full load attained. This quick rise in temperature is compensated for by liberal circulating water spaces and liberal mass of materials used in their construction; indeed, this very important point is still occupying the minds of our foremost Diesel engine makers, especially with regard to the adequate cooling of the piston head. However, so far as South African experience goes, there are no evidences of trouble on this score, and we may safely conclude that this trouble has been eliminated, although it may require special attention in engines of, say, 1,000 to 5,000 B.H.P.

Operation.

In operation, the engine, owing to sensitive governing, runs particularly smoothly; the governor automatically controls the supply of fuel oil to the fuel valve and is actually measured, and is in direct proportion to the load at all times. Indeed, a full load can be put upon these engines instantly from no load with scarcely one per cent. variation in the speed, the only attention required being an occasional release of the intercooler pressure and noting that all lubricating devices are in working order.

It is a well-known fact that running costs are principally supervision costs in most types of prime movers, but in the case of a Diesel engine you will observe that as we have such a reliable engine, practically indestructible and automatic in operation, that the human element is not so entirely necessary; indeed, one driver can easily take care of three engines running simultaneously, and then find time to grind in a valve or make small repairs, etc. This consequently only requires the services of a man at a comparatively low salary, and is the only cost other than fuel and lubricating oil. In brief, the total station costs for the production of a B.O.T. unit are in the neighbourhood of 1.1 pence at a station situated 150 miles from the coast, and paying a fairly high price per gallon for fuel oil; this must be considered good for such a low powered engine.

Repairs and Maintenance.

Repairs should and can always be carried out on the site. This will necessitate a small lathe, and mostly consist of grinding in valves every two to six week according to the calorific value of the fuel oil and the amount of foreign matter, acid, asphalt, etc., contained therein, and also its specific gravity, all of which I will deal with later, and which requires careful consideration by the Resident Engineer. In practice we have not had expensive repairs, the worst being two cracked exhaust valve guides, costing 15/- each. This has been discovered to be purely a question of expansion; the guides being screwed down too tightly had not sufficient room to expand, and sudden rise in temperature caused a crack. These two guides are still in use, having been repaired. Experience has now eliminated any further trouble on this score, and with this exception no new parts have been necessary, and only the abovementioned renewals have been carried out, all of which are done by an ordinary fitter.

Depreciation.

The depreciation of a Diesel engine, I venture to say, is at present not easily arrived at, and certainly is in direct proportion to the ability of the men responsible for its upkeep, and provided they are given ordinary care will last as long as any steam engine.

Adaptability to use Different Grades of Oil.

It is certain that during the life of a Diesel engine different grades and qualities of fuel oil will be met with, but in order to show how perfectly these engines automatically adapt themselves to different fuels, it would be practically impossible to observe any change in the running of an engine of this type if, quite suddenly, a change were made from a heavy residual oil with a gravity of, say, .94 and a calorific value of 20.500 B.T.U. per lb., and oil with a gravity of .800 and a calorific value of 19.100 B.T.U. per lb., the control being almost instantaneous; indeed, lubricating oil which has been filtered several times and is of no further use as a lubricant can be mixed and used with fuel oil and consumed in useful work. Of course it is quite unnecessary to remind you that with a fuel oil of, say, 20,000 B.T.U. calorific value we get more power than from a fuel oil of, say, 19.000 B.T.U.

Before leaving the practical side of this subject, it may be as well to explain the actual working cycle of a Diesel engine, which is very similar to the Otto cycle, although the double acting two-stroke Diesel is coming into very extensive use. For instance:—

1. On the first downward stroke of the piston air only is drawn into the cylinder, and in most types of engines the air is drawn through thin slots cut into the air inlet pipe to prevent foreign matter being drawn into the cylinder.

2. This air on the up stroke is rapidly and highly compressed, causing great heat.

3. At the top of compression fuel oil is sprayed through a pulveriser into the cylinder, and in consequence of the air being at that moment very hot the oil burns as it enters the cylinder. This spraying is not a momentary action, but is kept up during a great portion of the downward stroke, in fact almost to the bottom of the power stroke, and gives the Diesel engine one of its greatest advantages over any other form of internal combustion engine, inasmuch as it will be seen that no explosion takes place, but a rapid expansion over a distinct period of time, which tends to give that elasticity which is characteristic of the steam engine.

4. Just before the end of the expansion or power stroke the exhaust valve opens, which on the next up or exhaust stroke expels the products of combustion into the atmosphere. These products can scarcely be called products, as it is impossible to see anything leaving the exhaust pipe, the combustion being practically pefect—a most important point when considering this type of engine for residential districts.

From the foregoing it will be noticed that:—

(a) Air only is compressed, therefore there is no danger from pre-ignition.

(b) There is no carburettor or other means of vaporising the oil; it is simply sprayed into the cylinder by air pressure.

(c) There is no necessity for magnetos or hot tubes for ignition. Most Engineers will know what an advantage this is.

(d) Almost any form of residual oil can be used, even oils with a high flash point.

From the foregoing it will be plain to an Engineer that under conditions of great heat, produced from the rapid compression of air, great heat radiation must also take place through the walls of the cylinders and the piston, consequently ample cooling water spaces are provided, and it should here be noted that the Diesel engine, like all other internal combustion engines, runs best when fairly warm, and therefore the temperature of the cylinders must not be brought too low by a too liberal use of cooling water. In practice we find that with a water inlet temperature of, say, 70 degrees F. and an outlet temperature of 130 degrees F. that good, smooth and economical running is assured.

Efficiencies, etc.

The thermal efficiency of a Diesel engine is as high as 38 per cent.

The thermo-dynamic efficiency of a Diesel engine using oil at 19,500 B.T.U. per lb. is far in excess of a gas or steam plant, being as high as 32.5 per cent., and this can be taken to be fairly constant over a wide range of sizes of engines; from 50 to 500 H.P. the efficiencies at different loads being as follows:—

½ load	27.3 %
¾ load	30.5 %
Full load	32.5 %

This would allow, say, .8 per cent. for plant losses, etc.

It is well-known that the thermal efficiency of a modern compound condensing engine does not exceed 12½ per cent., and whilst the steam turbine has greatly improved upon this efficiency, it has still a long way to go before it approaches the efficiency of a Diesel engine in this respect.

The Mechanical and Combined Efficiencies.

On a trial of three Diesel engines of 100 B.H.P. each, the mechanical, generator and combined efficiencies were found to be greater at ¾ load than at full load (although this is not always the case). They were as follows:—

Mechanical efficiency 48.5 % $\frac{\text{B.H.P.}}{\text{I.H.P.}}$

¼ load Dynamo efficiency 81.0 % $\frac{\text{E.H.P.}}{\text{B.H.P.}}$ Water 73 % F. inlet.

Combined efficiency 39.3 % $\frac{\text{E.H.P.}}{\text{I.H.P.}}$ 102° outlet

Fuel oil .82 lbs. = E.H.P. hour 1.10 lbs. K.W. hour .66 lbs. per B.H.P.

Mechanical 61.3 %
½ load Dynamo 87.5 % Water 73 inlet.
104 outlet.
Combined 53.7 %
Fuel oil .52lbs. per B.H.P.
.60lbs. per E.H.P.
.80lbs. per K.W. hour.

Mechanical 70.8 %
¾ load Dynamo 88.5 %. Water 73 inlet.
112 outlet.
Combined 62.7 %
Oil .492lbs. per B.H.P.
.557lbs. per E.H.P.
.747lbs. per K.W. hour.

	Mechanical	70.3 %	
Full load	Dynamo	88.5 %	Water 72 inlet.
			116 outlet.
	Combined	62.2 %	
Oil	.450 lbs. per B.H.P.		
	.508 lbs. per E.H.P.		
	.681 lbs. K.W. hour.		

	Mechanical	72.5	
5 % Overload	Dynamo	88.5	Water 73 inlet.
			116 outlet.
	Combined	64.2	
Oil	.448 lb. per B.H.P.		
	.507 lb. per E.H.P.		
	.680 lb. per K.W. hour.		

It will scarcely be necessary for me to carry these figures further, as they speak for themselves, and, I think, should be a strong factor in enabling Engineers to come to a decision in deciding between steam and oil in moderate size plants; there certainly appears to be everything in favour of adopting this type of prime mover for such purposes as were mentioned in the opening lines of this paper.

Fuel Oil, etc.

This paper would not be complete if this important matter were not touched upon, as it is the essential of success in any scheme adopting Diesel engines. So far we have not tapped supplies of crude oil in this country, and at present it is imported, and I may here mention that my steam turbine friends can take note that this particular part of my paper strongly concerns them. To proceed, we have to import our fuel oil, and, most important of all, we have to pay excessive railway rates for its transport to different parts of the Union. These excessive rates make the adoption of Diesel engines an impossibility to dozens of small Municipalities throughout the Union, and it is time pressure were brought to bear to have these rates reduced pro bono publico.

I will give you a paradox in the Railway tariff book under the classification of goods. We find fuel oil at third-class rates, crude road bed oil for laying dust fourth-class rates. If by accident your railway note says 20 barrels of liquid fuel it will cost you second-class rate, but the peculiar point is this: The crude road bed oil and crude residual oil as used for Diesel engines is the same oil, with the same flash point, and often of the same specific gravity, consequently if you care to call it crude road bed you will get it carried cheaper. To carry this paradox further, ordinary petroleum has a flash point of 120 to 150 per cent. Fahr., and is called dangerous and rated at class 2nd. If your consignment is called liquid fuel it will pay the same rates. Most liquid fuel has an open flash test of 216 F. and a close test of 210 per cent. F., therefore is in the neighbourhood of boiling point before it flashes over, and, according to the Board of Trade, is considered absolutely safe for storage and transport—indeed, any oil from which inflammable vapour is obtained only when at a higher temperature than 73 per cent. F. is considered safe, and no restrictions are placed upon its storage, handling, or carriage, consequently I fail to see why an oil such as this—the import of which is essential to the development of this country, and is for the general public good—should pay excessive rates when it is impossible to set it alight except under proper conditions. It is fairly well known that the calorific value of oil fuels is in excess of the best of coal; indeed, liquid fuel has a calorific value of at least 30 per cent. greater than the best Welsh coal, and it has seemed somewhat peculiar to me that so many power stations still continue to do their steam raising with coal, using mechanical stokers, etc. This may be the most economical method when near a coal pit, but I cannot see why our friends at the coast ports could not adopt oil fuel for steam raising when the relative heat values of oil and coal are considered. The necessary appliances for injecting oil into all types of furnaces are very simple of operation and easy of erection, and can be controlled so easily that it is possible for one fireman to do the work of eight or ten. Add to this convenience of handling saving of labour, floor space, cleanliness, equal distribution of heat in the furnace, no loss of heat through opening of murnace doors, and increased efficiency because of the freedom from dirt and soot, and I think it would bear consideration. For convenience I give a few comparisons of heat values:—

Calorific and Evaporative Values.

It will be noticed that the evaporative value of any combustible is almost in a direct ratio to its calorific value, and is a useful thing to remember. For instance, we have:—

	Calorific Value.	Evaporative Value.
Bituminous Coal	14.000 B.T.U.	14.2 at 212 F.
Anthracite	15.000	15.5
Welsh	14.800	15.0
Coal Gas (averagei	21.000	21.7
Crude Petroleum	20.000	20.6

To sum up, the heat utilisation for 1 B.H.P. in different prime movers known to-day is as under:—

Steam engine with exhaust requires	7000	to	10000	heat units
Superheater and condensing steam turbine ..	4000	to	7000	,,
Producer gas engine	3000	to	3600	,,
Gas engine without producer	2300	to	3600	,,
Diesel engine	1800	to	2000	,,

In fine, the Diesel engine directly converts the heat of the natural fuel into work in the cylinder itself, and is therefore the simplest and most economical prime mover. As a further and even more convincing example of the great economies of this type of engine, I may perhaps be allowed to quote from an experiment carried out at the Turin Exhibition. A steam turbine and a large Diesel engine, both by the same maker, were worked together with the same liquid fuel. For the working of the steam turbine the whole boiler plant, with its chimneys, fuel supply apparatus, feed water with feed pumps, steam pipes, condensing plant, and an enormous water consumption, had to be provided, with the result that it consumed two-and-a-half or more times the fuel oil per B.H.P. required by the Diesel engine standing beside it. The latter being an entirely independent engine, without auxiliary plant, took up its fuel automatically, and consumed it direct in its cylinders without residue or smoke. It is, perhaps, fair to suppose that the steam turbine would have been still less efficient if the boiler had been fired with coal.

This paper would not be complete if it did not touch upon not only the adaptability of the Diesel engine, but upon its great development as a marine engine, and the size of the units which at present in use and under construction. We have had Krupps with a single cylinder, double-acting two-stroke Diesel, developing 2,000 B.H.P. as a land engine, and another by the same firm 3,500 B.H.P. two-stroke, reversible, six cylinder, as a marine engine. Burmeister and Wain are responsible for six engines, cylinders vertical, of an aggregate of 14,000 B.H.P., or just over 2,000 B.H.P. per engine unit. The largest, perhaps, in one engine unit is by Barclay, Curle & Co., with a 6,000 B.H.P. four-stroke, reversible. This is German and American practice. To get nearer home we have Messrs. William & Robinson, Sulzer, Swan & Hunter, Westinghouse, and Mirrlees, Bickerton & Day, who are responsible for the Diesel engines in the vessel Tyremount, in conjunction with the Mavor electric transmission. This firm is also responsible for Diesel engines for use in torpedo boat destroyers, submarines, and for the electric lighting of numerous British Dreadnoughts, also for driving large pumping plants and many other uses, the speeds ranging from 200 to 400 r.p.m.

In each case the builders have kept entirely to the vertical type, and in most instances the four-stroke is favoured.

These few examples go to show that Diesel engines are no longer in an experimental stage, and are worthy of consideration in any new or contemplated developments.

To conclude, I believe the time is near when the Government will have to provide supervision for power stations using Diesel engines. All Inspectors of Machinery should be not only acquainted with the general principles of the Diesel engine, but should be conversant with the necessary precautions to be taken, not only for the safety of the power station and plant, but also for the safety of the public generally, where such high pressures are kept, so to speak, bottled up, and to see that only men who have been trained and are thoroughly acquainted with this type of engine and the great pressures they are dealing with should be permitted to handle and run them. If this is done there is no reason to fear trouble, and I am certain that we shall in the future have as much confidence in the Diesel engine as is now given to the reciprocating steam engine, and its general adoption for all purposes is assured.

TOTAL QUEENSTOWN COSTS FOR ORIGINAL SCHEME.

Power Station Buildings	£726	0	0
2 only Twin Cylinder Diesel Engines, 100 B.H.P., each direct coupled to 2 only 65 K.W., D.C. 460 volt Generators..	4000	0	0
2 Foundations for Engines	200	0	0
Switchboard	500	0	0
Booster and Balancer	280	0	0
Battery, including erection	750	0	0
550 Poles, Steel Arms, etc., including delivery	2320	0	0
Cables and Feeder Pillar	1115	0	0
Overhead Copper Conductor	950	0	0
Insulators	125	0	0
260 Street Lamps and Brackets	260	0	0
16 Main Street Standards and Fittings at £16	256	0	0
250 Meters, including House Service Fuses and Boards ..	750	0	0
Fuel Oil Tanks for Storage, 3,600 gallons	65	0	0
Instruments	105	0	0
Tools, Lathe, etc.	200	0	0
Hand Carts, Ladders, etc.	45	0	0
Office Furniture	60	0	0
Sundries	93	0	0
	£12800	0	0

The scheme has now increased to £16,900 by the addition of a third engine, 400 extra meters, switchboard extensions, overhead extensions, and sundry other expenses. This constitutes the present capital cost of the scheme upon which we pay 6 per cent. interest, 1 per cent. Sinking Fund and 2¾ per cent, all-round depreciation.

The President moved a vote of thanks, which was duly seconded and heartily accorded by the members present, and the following discussion then proceeded:—

DISCUSSION ON PAPER READ BY MR. BELLAD-ELLIS.

Mr. A. S. Munro (Pietermaritzburg) asked "Whether the total station costs stated to be 1.1 pence per B.O.T. units included full capital charges on the plant"?

Mr. B. Sankey (Port Elizabeth) commented on the absence of any figures as to cost of crude oil, in the absence of which the superior economy claimed might or might not be advantageous. At the present time, whilst Diesel engines have a heat efficiency four times as great as steam plant, the cost of oil is more than five times as great as the cost of steam coal at the ports most distant from the coal-fields, such as Port Elizabeth and Cape Town, and hence this economy is more than counterbalanced by the high price of oil. There is, however, admittedly a useful sphere for Diesel oil engines in small towns with poor load factor, but even here the Locomobile Superheat Steam Engine is, in my opinion, a competitor with even greater claims to economy.

Mr. J. R. English (Heilbron): I personally am much obliged to Mr. Ellis for this paper on the Diesel engine, especially in regard to smaller-sized stations. I feel certain, however, that up-country, and anywhere near the Railways, or in fact where timber is obtainable at a fair price, the Diesel engine cannot compare with suction gas in the matter of fuel costs per unit generated. Taking Mr. Ellis' figures, I take it that the cost of fuel per unit generated, say in the Free State, from these engines with crude oil would work out somewhere about 1½d. In answer to Mr. Long, and as a comparison, a 70 B.H.P. suction gas set here (Heilbron), running on a poor load factor over 12 months—hours of running varying from 6 to 14 per day—the coal costs per unit generated worked out at .49d., and this with anthracite costing 26/6 per ton at the works. A smaller set of only 10 K.W. capacity ran for nine months practically 18 hours per day without trouble, generating current for pumping; the cost of fuel coming out at .53d. I feel sure that in regard to reliability the suction gas engines can compare favourably with the Diesel sets. There is only one other point I should like to draw attention to, i.e., on page 42 the author lays stress on the point of reliability, and in consequence of this that a poorly-paid man can be left in charge. In the last paragraph the author here wishes for expert Government supervision, and also that only highly-trained or skilled men should be allowed to run these plants. This point appears to have been a slip on the author's part, for I am certain that Mr. Bellad-Ellis is with us all in that any capable man in charge of machinery, and especially electrical plant, should receive adequate remuneration, and it is up to our Association for our mutual benefit to insist on this matter.

Mr. W. H. Blatchford (Greytown) mentioned that he was of the opinion that in deciding between steam and oil, for this country, the advantages lie in favour of the steam set as the prime mover. The initial cost of the Diesel installation is considerably greater than that of a steam engine and boiler, consequently the higher interest and depreciation charges may more than counterbalance the saving in fuel costs. The relative prices of oil and coal are certainly an important factor in drawing comparisons, but considering we have no suitable oil in this country the advantages certainly favour coal. Should a breakdown occur in the combustion engine it would be more serious than in that of a steam engine. Very small clearances between piston and cylinders are made in the interests of economy in fuel, which appears to be against reliability as regards fredom from breakdown.

Mr. Ellis mentions in the last paragraph of his paper: "Where such high pressures are kept bottled up it is necessary to see that only men who have been trained and are thoroughly acquainted with the Diesel engine should be permitted to handle and run them." The only advantage I can see over the steam engine is that the stand-by losses are altogether absent, which with a steam engine might reach a large amount. The advantage of being able to start up at less than a minute's notice is certainly a consideration, but are outbalanced by other disadvantages. The conditions as at present in my opinion are against the adoption of the Diesel engine as prime mover in this country.

Mr. Ellis is to be congratulated on having maintained an uninterrupted supply for the time mentioned in his paper, and I am sure we shall look forward with interest to learn something more from him about the Diesel engine at the next Congress.

Mr. Ellis states that the total capital cost for two 63 K.W. sets, complete with generators, etc., is £12,800, or over £100 per kilowatt installed. I may mention that in Greytown the complete installation works out at £45 per kilowatt installed.

Mr. F. Castle (Oudtshoorn) expressed his appreciation of Mr. Ellis' paper. In his opinion Mr. Ellis had overrated the possibilities of Diesel oil engines and fuel oil. The whole question comes to this: that as long as South Africa was not an oil-bearing country I fail to see how large Diesel oil engines can be a profitable source of power. I am of a firm opinion that with fuel oil at present day prices a suction or pressure bituminous gas plant would prove more economical than Diesel engines. We must not overlook the fact that the railage on fuel oil is greater than that for coal, also the fuel oil is more or less controlled by a trust. As regards the satisfactory running of a Diesel engine, I am with Mr. Ellis. Providing the engine is of a good make, and running at moderate speed. one can expect as good running, if not better, than any other type of internal combustion engine. At Oudtshoorn we have some 305 K.W. in Diesel electric sets; 180 kilowatts have been in use for five years, and providing the blast in the starting bottles is correct we never get a failure in starting. The only running failures have been due to the air compressor intermediate cooling coil bursting. These are copper spiral coils, which are supported in the cooling vessel, and cool the first stage compressed air before it enters the second stage compressor. These coils wear thin after a time and generally burst on peak load, when the pressure in the coil is the highest. I have these coils removed periodically and weighed. When the weight has fallen to 80 per cent. of the original weight I discard the coil and put in a new one. Since carrying out this practice I have had no further trouble.

Mr. John Roberts (Durban): The Association is under an obligation to Mr. Ellis for the great pains he has taken with his paper, and for the clear manner in which he has described the working of the Diesel engine. Under Durban conditions the Diesel engine has never presented itself to us seriously as a prime mover for generating electricity, and not having looked into the question seriously I have learned a good deal of what goes on in a Diesel engine cylinder of which I must confess I was ignorant. I did not know before, for instance, that there is a distinct difference between the way the gas does its work in the Diesel engine and in the ordinary paraffin or petrol engine. In the first case Mr. Ellis has shown that the gas may be said to burn more or less continuously throughout the stroke, whereas we all know that in the latter case it is burnt almost instantaneously on ignition by the spark.

Dealing with the commercial aspect of his subject, I cannot altogether agree with him that oil can be supplied sufficiently cheap at coastal towns to warrant substituting crude oil for coal. I understood him to say that the heat units in the oil he is using amount to about 20,000 per lb. against, say, 12,500 for coal, which is about 50 per cent. in excess. Seeing, however, that the cost of the oil would be very much more than 50 per cent. greater than the price of coal delivered, I cannot agree that even with the greater ease in firing, freedom from ashes, etc., the net result would be a saving. The paper, however, must be valuable to those who have to cater for the needs of a small town where both capital expenditure and running expenses have to be cut down to the minimum. In my opinion the man who sets out to provide a plant for a town of, say, 2,000 inhabitants, has to exercise the most careful discrimination in choosing and operating a plant which will show a satisfactory profit and loss account, and as South Africa is dotted with small towns of this size and under, we cannot have too much information on the experiences of those Engineers who can throw fresh light on a difficult subject. I hope next year we shall hear more on this question from Engineers in charge of small stations.

Mr. T. Millar (Harrismith): I feel pleased to be able to support the remarks made by Mr. Roberts in so far as he has dealt with the paper read by Mr. Bellad-Ellis. I have had an experience something similar to Mr. Ellis', namely, Government delay in granting sanction of loans on new Municipal electrical undertakings. Some two years ago the property owners in Harrismith gave the Town Council power to raise the sum of £12,000 for the purpose of installing additional electrical plant in anticipation of a day load. We had obtained expert advice on the matter, and a report was sent to the Government. In January of the present year the Government Engineer paid a visit to Harrismith to make certain enquiries re local conditions, etc. Since then we have heard nothing in the matter, and I think that we, as an Association, should deal with the Government in such matters. I have to thank Mr. Ellis for bringing this matter before us in his very instructive paper.

Mr. E. Poole (Durban): To the smaller Municipalities particularly should Mr. Bellad-Ellis' paper appeal, and I think a tabulation showing comparisons between Diesel, Suction Gas, Oil, Steam, etc., plants would be of great interest with regard to floor space occupied and capital cost per K.W. installed (as far as concerns engine plant only). Mention is made as to the adaptability of using various grades of oil, but as it seems to be at the expense of losing power in using a low grade oil I do not see where the advantage is unless it is that in the event of any delay in delivery of the regular supplies the Engineer can rest content that practically any sort of oil will carry him through, but may I ask does using a low grade oil mean using more oil per H.P.?

The last paragraph of the paper rather upsets a lot of the previous remarks where one is led to think that in the hands of an average low-paid Engineer a Diesel engine is quite successful, whereas in the concluding remarks we read the Engineers must be trained and thoroughly acquainted men, and further than that, Government Inspectors should actually supervise stations using Diesel engines, and with such contradictory remarks one may hesitate before embarking on such a scheme in case of difficulty in getting men to run the plant successfully.

Mr. T. Jagger (Ladysmith) raised a point in connection with the cost of fuel in this country for the Diesel engines as compared with the cost of coal, more especially for electric power stations situated up-country, where the price of coal was much less than at towns nearer the coast. Mr. Jagger also drew attention to the fact that, whereas Mr. Bellad-Ellis gave 1d. per unit as his fuel consumption on the Diesel engine, the full cost at Ladysmith on a very similar load and with Willans' steam engines was .49d. per unit for last year, at the same time mentioning the cost of coal as 6/9 per ton in the bunkers.

MR. BELLAD-ELLIS' REPLY (communicated).

Replying to the questions raised seriatim: The station costs of 1.1d. per unit include wages, salaries, fuel and lubricating oil and repairs and maintenance. Cost of fuel oil per unit .44d. at the coast, .85d. at Grahamstown, but latterly this has fallen to .67d. No claim is made that best results are obtained in the larger sizes against steam turbines; the arguments refer to their uses for small towns up to, say, 250 H.P., for which their special advantages are particularly suitable. Only specially trained and skilled men should erect and undertake important repairs, but a comparatively cheaper man can drive and undertake minor adjustments under the guidance of a good station Engineer, and given these necessary conditions the Diesel is of equal reliability, greater fuel economy, and no greater first cost than steam plant for small towns of poor load factor, except where coal is very cheap. Fuel oil and its cost, including railage, is generally the deciding factor, and in the absence of special railway rates and low-landed costs it offers no attraction to cities such as Durban. Given cheap fuel oil supplies in the Colony, the use of oil for stand-by steam or oil-driven plant would merit serious consideration in the large towns.

At the conclusion of the discussion it was decided not to meet in the afternoon to enable the members to see something of Johannesburg and district.

By invitation of the S.A. Institution of Electrical Engineers the delegates attended at 8 p.m. at the Johannesburg School of Mines, and were welcomed by the Vice-President, Professor Buchanan (in the unavoidable absence through indisposition of the President, Mr. Bernard Price).

Mr. Bellad-Ellis returned thanks on behalf of the delegates.

Professor J. H. Dobson then proceeded to read a paper on "The Distribution System of Johannesburg," which has already been fully reported in the technical press, and is recorded in the Proceedings of the S.A. Institution of Electrical Engineers.

FRIDAY, NOVEMBER 19th, 1915.

The Congress met at 10.30 a.m. at the Town Hall, Johannesburg, when the Rules and Constitution of the Association, as drawn up by the Sub-Committee formed for that purpose, were submitted, discussed, and with certain alterations and additions, adopted by the meeting. Full particulars will be found on page

Mr. John Roberts (Durban) proposed, seconded by Mr. Long (Cape Town), that it be an instruction that the Hon. Secretary shall notify all members of any important business transacted during the year by the Council. This was agreed to.

It was resolved that the Chairman or other nominee of the Committee of any Municipal Electric Supply or Tramway undertaking, of which the Engineer is a member of the Association, shall be invited to attend the next Congress at Cape Town.

Mr. John Roberts (Durban) proposed, and it was seconded and agreed, that members who intend to contribute papers at the Annual Congress shall send their papers, together with the necessary copies, to the Hon. Secretary at least one month before the Annual Congress, so that he may circulate them among the members of the Association.

The following resolution was adopted: That the Council be empowered to charge for copies of the proceedings when found necessary.

ELECTION OF OFFICERS AND COUNCIL.

Mr. E. T. Price (Johannesburg) was unanimously elected Hon. Treasurer.

For the election of the three members of Council five names were duly proposed and seconded, and, as the result of the ballot, the following three members were elected:—

Messrs. John Roberts (Durban).
B. Sankey (Port Elizabeth).
W. Bellad-Ellis (Queenstown).

(A full list of the Executive Council appears on the front page.)

In the afternoon the visitors were shown round the Municipal Power Station, Distribution System, and the Municipal Abattoirs and Live Stock Market.

SATURDAY, NOVEMBER 20th, 1915.

The Congress met at the Town Hall at 9 a.m.

It was resolved that a record of the proceedings of the week be sent to all members.

Mr. B. Sankey (Port Elizabeth) proposed that the thanks of the Association be conveyed by the Hon. Secretary to the following:—

The Local Institution of Electrical Engineers.
Johannesburg Town Council.
The Mayor of Johannesburg.
The Chairman, Tramway and Lighting Committee.
The Committee of the Rand Club for appointing us members.
The Victoria Falls and Transvaal Power Co.
The Directors of the Randfontein and Crown Mines.
The various parties who placed motor cars at the disposal of the members.

Mr. Munro seconded, and it was carried.

Mr. McDonough (Bethlehem) proposed that it be an instruction to the Council to notify the responsible Minister of the Union of South Africa of the formation of this Association, informing him of the objects of the Association, and that the Council of the Association will be pleased to offer its services in the nature of any advice which the Council may be able to give on any electrical matters arising in the Union of South Africa which involve the welfare of Municipal electrical undertakings and questions of such systems in the Union.

Mr. B. Sankey (Port Elizabeth) seconded, and the motion was carried.

Mr. John Roberts (Durban) proposed, seconded by Mr. Munro (Pietermaritzburg), that a letter in the same tenor as the one to the Minister be addressed to the various Municipalities. This was also carried unanimously.

The new Mayor of Johannesburg, Councillor J. W. O'Hara, and the new Chairman of the Tramway and Lighting Committee, Councillor J. Mulvey, addressed a few words of welcome to the meeting. Mr. John Roberts and Mr. B. Sankey replied, thanking them both for the kind remarks made.

Professor J. H. Dobson also spoke, informing the Mayor and the Chairman of the T. and L. Committee of the objects of the Association, and thanking them for the interest shown in the Association.

It was resolved that the Committee be instructed that for the ensuing year any Engineer formally in charge of an electrical undertaking be admitted a member of the Association.

Mr. G. H. Swingler proposed, seconded by Mr. John Roberts, that it be an instruction to the Council to endeavour to get the Railway Authorities to give a concession to those members of the Association attending the Congresses. Agreed.

Mr. B. Sankey stated that the various railways at Home grant refunds in such cases.

Statistics.

Mr. Castle suggested that the various Municipalities be asked to make up statistics, the same as is done in England.

The Association of Municipal Electrical Engineers.

(UNION OF SOUTH AFRICA)

LIST OF MEMBERS.

The following attended the first Congress at Johannesburg, and therefore became members of the Association under Rule 8 of the Constitution:

Messrs. M. McDonough, Bethlehem.
W. F. Long, Cape Town (Vice-President).
G. H. Swingler, Cape Town.
J. Roberts, Durban (Member of Council).
E. Poole, Durban.
W. H. Blatchford, Greytown.
T. Millar, Harrismith.
J. H. Dobson, Johannesburg (President).
F. T. Stokes, Johannesburg (Hon. Secretary).
E. T. Price, Johannesburg (Hon. Treasurer).
T. Jagger, Ladysmith.
T. C. Wolley-Dod, Pretoria.
B. Sankey, Port Elizabeth (Hon. Secretary from Aug., 1916).
(Member of Council).
A. S. Munro, Pietermaritzburg.
F. Castle, Oudtshoorn.
N. D. Ross, Potchefstroom.
W. Bellad-Ellis, Queenstown (Member of Council).
W. Leonard, Standerton.
— Ward, Newcastle.
L. L. Horroll, Pretoria.
22 L. B. Proctor, Boksburg.
W. S. Guildford, Boksburg.

The following members have since been elected under Rule 9 of the Constitution:—

Messrs. Norman Lee, Somerset East, April 10, 1916.
G. H. A. Lewis, King Williamstown, April 10, 1916.
E. J. Hamlin, Stellenbosch, April 10, 1916.
J. Vowles, Klerksdorp, May 19, 1916.
C. W. McComb, Springs, October 14, 1916.
9 H. Brittle, Cradock, October 26, 1916.
J. W. S. Clunas, Cape Town, November 6, 1916.
R. A. Stoker, Kroonstad, November 8, 1916.
W. Douglas, Ermelo, November 9, 1916.

Mr. John Roberts proposed that the Council endeavour to obtain papers on certain subjects, such as:—

The most suitable form of statistics.

The question of street lighting in those towns where there is difficulty with trees.

Tariffs.

Commercial control by the Engineer of Municipal electrical undertakings.

Mr. John Roberts proposed a very hearty vote of thanks to the President, Professor J. H. Dobson, for the interest he has shown in the proceedings and the Association. Mr. Blatchford seconded Mr. Roberts' remarks heartily, and the meeting unanimously agreed.

Mr. Dobson replied, thanking the members for their hearty vote, and said that anything he may have done had not been in the nature of irksome work, and it gave him great pleasure to see the response. He expressed gratitude to the Hon. Secretary for the work he had done.

Mr. B. Sankey seconded the vote of thanks to Mr. Stokes, the Hon. Secretary, for his great services during the week's proceedings, and for what he has taken in hand for the future.

The final meeting of the Congress then terminated at 11.30 a.m., all members being of the opinion that a most instructive and interesting week had been spent, and that the business so far accomplished foreshadowed a useful and successful future for the Association.