PROCEEDINGS

of the

Thirteenth Convention

of the

Association of Municipal Electricity Undertakings.

of South Africa and Rhodesia.

HELD AT

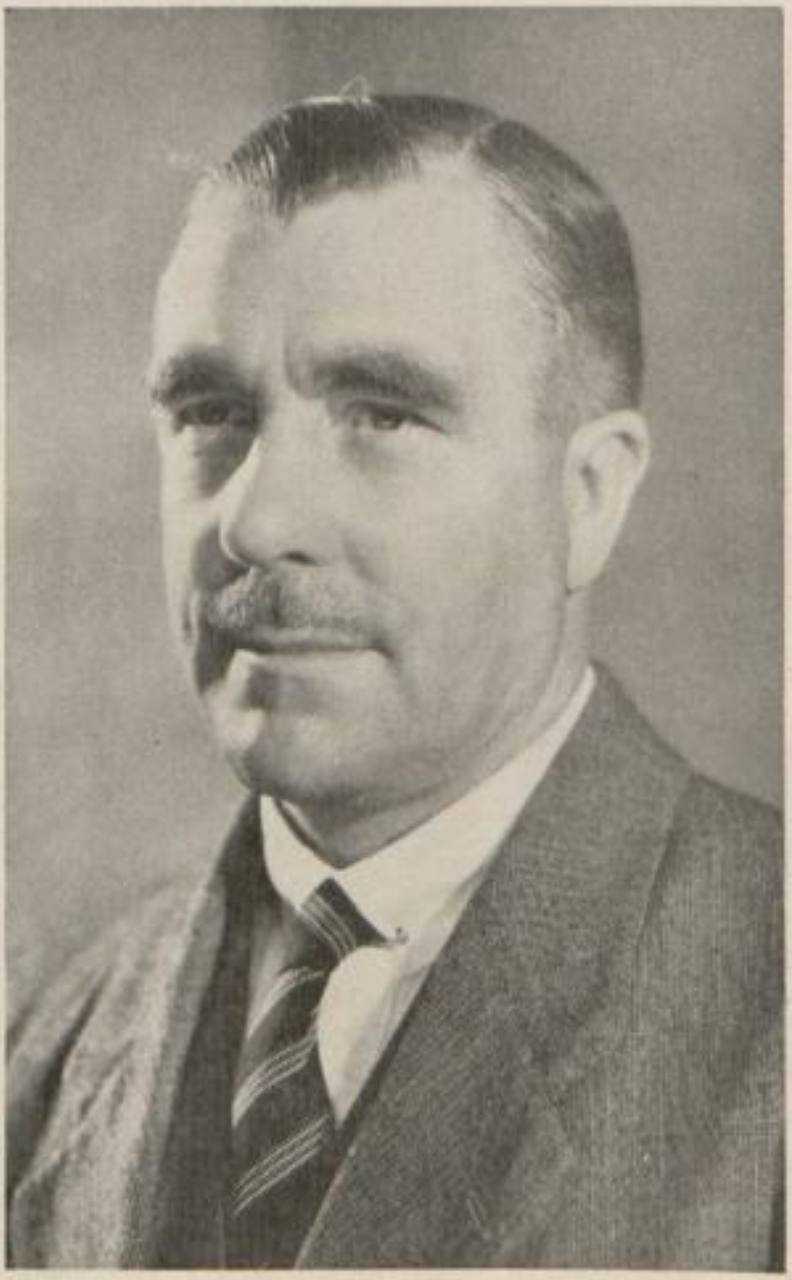
Pietermaritzburg

NATAL.

From Monday, September 23rd to Thursday, September 26th.,

1935.

PRICE FIVE SHILLINGS.



G. G. EWER, PRESIDENT
City Electrical Engineer and Tramways Manager,
PIETERMARITZBURG.

PROCEEDINGS

of the

Thirteenth Convention

of the

Association of Municipal Electricity Undertakings.

of South Africa and Rhodesia.

HELD AT

Pietermaritzburg

NATAL.

From Monday, September 23rd to Thursday, September 26th.,

1935.

PRICE FIVE SHILLINGS.

INDEX.

INDEX.

ASSOCIATION OF

Municipal Electricity Undertakings.

of South Africa and Rhodesia.

Founded 1915.

EXECUTIVE COUNCIL, 1935.

President :

G. G. EWER (Pietermaritzburg).

Vice-President :

A. RODWELL (Johannesburg).

Past Presidents :

A. R. METELERKAMP (Bulawayo).

L. L. HORRELL (Pretoria).

Councillor Members :

J. McLEAN (Port Elizabeth).

T. P. GRAY (Johannesburg).

H. W. DELY (Pretoria—alternate).

Other Members :

G. H. SWINGLER (Cape Town).

J. H. GYLES (Durban).

T. MILLAR (Harrismith).

E. A. BEHRENS (Port Elizabeth).

Secretary and Treasurer :

E. POOLE,

P.O. Box 147 — Durban.

Association of Municipal Electricity Undertakings.

of South Africa and Rhodesia.

MEMBERS AND DELEGATES AT PIETERMARITZBURG, 13th CONVENTION, SEPTEMBER 23rd to 26th, 1935.

Seated—Executive Council of the Association. (left to right).
Councillor C. W. Fowkes (Cape Town) (alternate); A. R. Metelerkamp (Bulawayo) Past President; Councillor J. McLean (Port Elizabeth) Member of Council; H. A. Eastman (Cape Town); L. L. Horrell (Pretoria) Past President; Councillor A. T. Allinson (Mayor of Pietermaritzburg); G. G. Ewer (Pietermaritzburg) President; A. T. Rodwell (Johannesburg) Vice President; E. Poole, Secretary and Treasurer; Councillor H. W. Dely (Pretoria) Member of Council (alternate); J. H. Gyles (Durban) Member of Council; T. Millar (Harrismith) Member of Council; A. E. Behrens (Port Elizabeth) Member of Council.

ASSOCIATION OF

Municipal Electricity Undertakings.

of South Africa and Rhodesia.

PAST OFFICERS AND MEMBERS OF COUNCIL.

	Past Presidents :		Sec. and Trea. :
1915-17	J. H. DOBSON,	Johannesburg.	F. T. Stokes : E. T. Price.
1917-19	J. ROBERTS,	Durban.	E. Poole.
1919-20	B. SANKEY,	Port Elizabeth.	E. Poole.
1920-22	T. C. W. DOD,	Pretoria.	L. L. Horrell.
1922-24	G. H. SWINGLER,	Cape Town.	H. A. Eastman.
1924-26	J. ROBERTS,	Durban.	E. Poole.
1926-27	B. SANKEY,	Johannesburg.	R. G. Tresise.
1927-29	J. M. LAMBE,	East London.	P. Adkins.
1929-31	R. MACAULAY,	Bloemfontein.	E. Poole.
1931-32	L. L. HORRELL,	Pretoria.	E. Poole.
1932-34	L. F. BICKELL,	Port Elizabeth.	F. A. P. Perrow.
1934-35	A. R. METELERKAMP,	Bulawayo.	E. Poole.

Past Ordinary Members of Council :

1915-17	J. Roberts; W. Bellad Ellis; B. Sankey.
1917-19	W. Bellad Ellis; G. Stewart; T. C. W. Dod; T. Jagger.
1919-20	W. Bellad Ellis; G. Stewart; E. T. Price; A. S. Munro.
1920-22	L. F. Bickell; T. Millar; L. B. Proctor; E. Poole.
1922-24	L. F. Bickell; T. Millar; R. W. Fletcher; J. Roberts.
1924-26	T. Jagger; A. S. Munro; T. Millar; L. F. Bickell.
1926-27	L. F. Bickell; T. C. W. Dod; T. Millar; E. Poole.
1927-29	L. F. Bickell; R. A. Young; T. Millar; E. Poole.
1929-30	L. F. Bickell; T. Millar; F. C. D. Mann; G. H. Swingler; A. Rodwell.
1931-32	T. Millar; F. C. D. Mann; G. H. Swingler; A. Rodwell.
1932-34	T. Millar; J. H. Gyles; G. H. Swingler; A. Rodwell.
1934-35	T. Millar; J. H. Gyles; G. H. Swingler; A. Rodwell.

RULES AND CONSTITUTION.

The Association of MUNICIPAL ELECTRICITY UNDERTAKINGS of SOUTH AFRICA and RHODESIA.

---

1. TITLE.

The name of the Association shall be "The Association of Municipal Electricity Undertakings of South Africa and Rhodesia."

2. OBJECTS.

The objects for which the Association is formed are :—

(a) To promote the interests of Municipal Electricity Undertakings.

(b) To bring Municipal Electrical Engineers and Chairmen and Members of Municipal Electricity Committees together.

(c) To arrange and hold periodically meetings for the reading of papers and discussions of subjects appertaining to Municipal Electricity Undertakings.

(d) To take such action as may be lawful and expedient for the protection and defence of the rights or interests of Municipal Electricity Undertakings.

3. MEMBERSHIP.

The Association shall consist of :—

(a) Honorary Members.
(b) Councillor Members.
(c) Engineer Members.
(d) Associate Members.
(e) Associates.

All Hon. Members and Members of the Association of Municipal Electrical Engineers shall ipso facto become members of the Association of Municipal Electricity Undertakings and existing Associate Members shall be eligible to transfer to the class of Associate.

4. QUALIFICATIONS.

The qualifications for admission to the Association shall be as follows :—

(a) **Honorary Members** shall be distinguished persons who are or who have been intimately connected with Municipal Electricity Undertakings and whom the Association especially desires to honour for exceptionally important services in connection therewith.

(b) **Councillor Members.** The Member whose Chief Electrical Engineer shall have qualifications acceptable to the Council of the Association shall be the Committee appointed by the Municipality or Local Authority to have control over its Electricity Undertaking and shall be represented as regards its qualifications to vote by one member of such Committee.

(c) **Engineer Members.** The Member shall be the Chief Electrical Engineer engaged on the permanent staff of an Electricity Undertaking owned by a Municipality or Local Authority and who has had a thorough trainir.g in Electrical Engineering and is otherwise acceptable by the Council of the Association.

(d) **Associate Members.** The Member shall be a Technical Assistant engaged on the permanent staff of any Electricity Undertaking represented by its Councillor Member and/or Engineer Member.

(e) **Associates.** Any Member resigning from the class of Engineer Member or Associate Member shall be entitled to apply for transfer to the class of Associate.

An Associate may also be an Engineer in the employ of the Victoria Falls and Transvaal Power Company or the Electricity Supply Commission, who may be engaged in the public supply of electricity to Municipalities.

5. ADMISSION OF MEMBERS.

(a) The election of Honorary Members and other classes shall be vested in the Council.

(b) Councillor Members may be admitted on an application signed by the Town Clerk of the Municipality or Local Authority concerned.

(c) Every candidate for election into the Association as Engineer Member shall make application on the prescribed form suitably endorsed by two supporters who shall be either Engineer Members, Councillor Members or Members of the Committee of the Municipality or Local Authority in charge of the Electricity Undertaking of which the applicant is Chief Electrical Engineer.

(d) Every candidate for election into the Association as Associate Member or Associate shall make application on the prescribed form suitably endorsed by the Engineer Member on whose staff he is engaged.

(e) Every candidate for transfer to the class of Associate shall make application in writing for transfer.

6. CONTRIBUTIONS.

Contributions shall become due and payable annually on the 1st day of September which shall constitute the new Financial Year of the Association.

(a) **Honorary Members** shall not be required to pay any contribution.

(b) **Councillor Members.** In the case of the Committee appointed by a Municipality or Local Authority to have control over the Electricity Undertaking the undermentioned scale of contribution shall apply :—

up to ½ million	2 guineas.
up to 1 million	3 „
up to 10 million	4 „
all over 10 million	5 „

(c) **Engineer Members.** The contribution of an Engineer Member in the service of a Committee making a contribution shall merge into and form part of such contribution. When a Committee is not a Member or resigns from Membership the Engineer Membership contribution shall be two (2) guineas.

(d) **Associate Members and Associates.** The
(e) contribution of Associate Member or Associate shall be one (1) guinea.

Part Year contribution. All members shall pay the contribution for the year in which they are elected without reference to the period of the year at which their election takes place and they shall be entitled to receive a copy of the Proceedings or any other publications issued during such year.

Arrear Contributions. No class of Member whose contribution is six months in arrear shall be entitled to attend or take any part in any of the meetings of the Association or to receive any of the Association's publications.

Any class of Member whose contribution is in arrear at any Convention shall deem to have forfeited claim to membership and his name may, by the Council, be removed from the register of the Assciation, but he shall nevertheless be liable for such arrears up to the date of his name being removed.

7. COUNCIL.

Management. 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.

Members of Council. The Council shall consist of a President Vice President, two Immediate Past Presidents, all of whom shall be Engineer Members, and six other Members, two of whom may be Councillor Members.

Officers of Council. The Officers of the Council shall be the President, Vice President and Secretary & Treasurer.

Election of Council. Officers and Members of the Council (other than the Secretary & Treasurer) shall be elected by nomination and ballot at the Convention, and shall hold office until the next Convention. In the event of a vacancy occurring during the year the remaining members shall have power to appoint a member to fill the vacancy.

Co-option. The Council shall have power to co-opt any members of the Association or other person for any special purpose whose services in their opinion may advance the objects of the Association.

Election of Secretary & Treasurer. The Council shall appoint and from time to time determine the remuneration (if any) and prescribe the duties of the Secretary & Treasurer who shall hold office during the pleasure of the Council.

8. MEETINGS.

Council. The Council shall meet as often as the business of the Association may require and at any meeting three shall constitute a quorum.

Convention. The Association shall hold Conventions yearly, (of which the local Press of the town in which the Convention is held shall be given full particulars) as far as may be conveniently arranged, and at that meeting the Secretary & Treasurer shall present the Report and Balance Sheet of the Association for the immediate past period.

Quorum. At any meeting of the Association 15 shall form a quorum.

Chairman. 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.

In the absence of the President, it shall be the duty of the Vice-President to preside at the meeting 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.

Resolve into Committee. 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.

Sectional Voting. When a motion is before any Convention or meeting of the Association it shall be competent for any member of either the Councillor or Engineer sections to apply to the Chairman for a "Vote by Section." This application shall be granted by the Chairman whereupon each of these sections shall vote separately on the motion and unless a majority shall be obtained in each section the motion shall be lost. On a sectional vote being called for Associate Members and Associates shall not be entitled to vote.

Thirteenth Convention

PIETERMARITZBURG.

Programme

Monday, September 23rd.

8.30 a.m.—Meeting of Council.

9.30 a.m.—Registration. Issue of Programmes, etc.

10.0 a.m.—Official Opening of Convention by His Worship the Mayor of Pietermaritzburg. (Councillor A. T. Allison, M.P.C.)

10.30 a.m.—Annual General Meeting. (Municipal Delegates and visitors may attend, but only Members are entitled to vote.)

AGENDA :

1. Annual Report of Secretary & Treasurer.
2. Election of President.
3. Valedictory Address by Retiring President.
4. Presidential Address.
5. New Rules and Constitution.

6. Place of Meeting of next Convention.
7. Election of Secretary and Treasurer and Officers.
8. Licensing of Electricians.
9. General Business :— "Earthing." Sub-Committees' reports, &c.

The following are the retiring Officers :—

President —A. R. Metlerkamp: Bulawayo.
Vice President —G. G. Ewer: Pietermaritzburg.
Past Presidents—L. L. Horrell: Pretoria.
R. Macaulay: Bloemfontein.
Other Members —G. H. Swingler: Cape Town;
J. H. Gyles: Durban;
A. Rodwell: Johannesburg;
T. Millar: Harrismith.

1.0 p.m.—Luncheon Adjournment.

2.30 p.m.—Paper by Mr. F. Stevens (Alice) "The Alice Municipal Electricity Supply Undertaking."

4.0 p.m.—Visit to Broadcasting Station and "World's View."

8.0 p.m.—Civic Reception and Dance—City Hall.

Tuesday, September 24th.

8.30 a.m.—Council Meeting.

9.30 a.m.—Official Photograph at "Electricity House."

10.0 a.m.—Paper by Mr. A. H. Albertyn (Cape Town) "Some Considerations in the Selection and Maintenance of Electricity Meters."

1.0 p.m.—Luncheon Adjournment.

2.30 p.m.—Visits to Electricity Supply Commission Pietermaritzburg Substation, and Nestlés Chocolate Factory.

4.30 p.m.—Official Opening of Electrical Exhibition at the City Hall by His Worship the Mayor.

8.0 p.m.—Performance at Grand Theatre.

Wednesday, September 25th.

8.30 a.m.—Council Meeting.

9.30 a.m.—Paper by Mr. H. Littlewood (Johannesburg) "Street Lighting."

11.30 a.m.—Paper by Messrs. D. H. Hugo and J. Wilson (Pretoria) "High Tension Feeder Protection."

2.30 p.m.—Visits to Water Purification Works, and Natal Tanning Extract Co's Factory.

4.0 p.m.—Tea at Botanical Gardens.

7.30 p.m.—Cabaret at Imperial Hotel.

Thursday, September 26th.

8.30 a.m.—Council Meeting.

9.30 a.m.—Paper by Mr. A. R. Sibson (Graaff Reinet) "Some Notes on Power Station Water Prolems."

The Meeting will terminate by 12 noon, to give coastal passengers time to motor to Durban before the Mail Boat leaves.

Association of

Municipal Electricity Undertakings.

of South Africa and Rhodesia.

MEMBERS AND OTHERS ATTENDING THE CONVENTION.

ENGINEERS AND COUNCILLORS :

ALICE—
F. Stevens.

BENONI—
G. R. S. Wright.

BOKSBURG—
T. S. Fitzsimons.

BLOEMFONTEIN—
R. Macaulay.
Councillor G. Smit.

BULAWAYO—
A. R. Metclerkamp.

CAPE TOWN—
H. A. Eastman.
Councillor C. W. Fowkes.

COLESBURG—
J. Van der Walt.

CRADOCK—
A. Rossler.
P. de K. van Heerden, (Town Clerk).

DE AAR—
C. H. Dwyer.

DUNDEE—
L. Ralston.

DURBAN—
J. H. Gyles.
Councillor H. B. Gemmell.

EAST LONDON—
A. Foden.

ERMELO—
G. Dekenah.

GLENCOE—
H. T. Turner.
Councillor Mrs. H. J. M. Smith.

GRAAFF-REINET—
A. R. Sibson.

HARRISMITH—
T. Millar.

JOHANNESBURG—
A. T. Rodwell.

KLERKSDORP—
H. Bahr.
Councillor J. J. Oosthuizen.

KOKSTAD—
W. Mail.

KRUGERSDORP—
G. J. Muller.
Councillor R. C. Coppinger.

LADYBRAND—
W. Rossler.

LADYSMITH—
T. Jagger.
Councillor A. W. Cresswell.

LYDENBURG—
W. P. Davis.

MAFEKING—
G. E. H. Jones.

NIGEL—
H. Bickley.
Councillor H. Mills.

OUDTSHOORN—
R. D. Coulthard.

PAARL—
H. J. Relihan.

PIETERSBURG—
L. B. Sparks.

PIET RETIEF—
T. M. Mocke.

PIETERMARITZBURG—
G. G. Ewer.
Councillor A. T. Allison (Mayor)
" D. J. Berry-Jennings.
" A. G. Lugsdin.
" G. F. Robbins.
" Mrs. E. M. Shirley.
J. McGibbon (Town Clerk).
F. R. Cooper (City Treasurer).
B. H. Davrill (City Engineer).

PORT ELIZABETH—
E. H. Behrens.
Councillor J. McLean.

POTCHEFSTROOM—
W. D. Ross.
Councillor I. G. Theron.

PRETORIA—
L. L. Horrell.
Councillor H. W. Dely.

QUEENSTOWN—
T. P. Ashley.

ROBERTSON—
J. Hooper.

ROODEPOORT—
H. Groom.
Councillor A. B. van der Linde (Mayor).
" D. Simpson.

SALISBURY—
J. S. Clinton.
Councillor L. B. Fereday (Mayor).
" R. L. Phillips.

SPRINGS—
A. Q. Harvey.
Councillor B. G. Fourie.
" D. V. Hassett.

STELLANBOSH—
D. W. Ritson.

STANDERTON—
C. E. Gregor.

UITENHAGE—
A. E. Elliott.

VOLKSRUST—
G. C. Brown.
Councillor W. W. Cook.

VRYBURG—
P. C. Grandin.

ASSOCIATE MEMBERS :

B. Marchand, Witbank; F. Castle, Capetown; L. B. Proctor, J.H.Burg.

SUNDRY DELEGATES :

Electricity Supply Commission :	W. H. Milton,	Johannesburg.
" " "	D. S. Primmer,	Colenso.
" " "	S. Ward,	Pietermaritzburg.
Electricity Control Board :	J. L. Hill,	Pretoria.
World's Power Conference (Local Committee)	G. R. D. Harding,	(Secretary).
South African Railways and Harbours (Electrical):	W. R. Owens.	
Institution of Electrical Engineers (S.A.):	A. T. Rodwell.	
Natal Institute of Engineers :	E. L. Damant,	President.
" " "	A. C. Collier,	Hon. Secretary.
Chief Inspector of Factories :	C. H. Clutterbuck.	Pretoria.
Public Works Department (Electrical):	H. Aldsworth,	Pietermaritzburg.

ELECTRICAL TRADES :

A.E.G. Engineering Co. (Pty) Ltd.:	A. Heydorn,	Johannesburg.
British General Electric Co. Ltd. :	H. Littlewood,	Johannesburg.
" " " " "	S. G. Mortimer,	Johannesburg.
" " " " "	R. A. Stevenson,	Johannesburg.
" " " " "	P. Tolkein,	Durban.
T. Barlow & Sons (S.A.) Ltd.:	J. F. Mason,	Pietermaritzburg.
Chloride Electrical Storage Co. Ltd.	A. C. Tilley,	Cape Town.
English Electric Co., Ltd.	B. E. Mahon,	Johannesburg.
Hubert Davies & Co., Ltd. :	T. H. Harris,	Durban.
J. Martial & Sons :	J. Martial,	Pietermaritzburg.
Reynolds Sons & Partners, (Pty.), Ltd. :	H. Shermer,	Johannesburg.
Reyrolle (N. O. Curry) :	W. J. Gibbons,	Johannesburg.
Siemens (S.A.), Ltd. :	P. Frank,	Johannesburg.
" " "	H. J. S. Cremer,	Johannesburg.
" " "	Capt. B. G. Angel	Johannesburg.
South African Gen. Elec. Co. Ltd. :	C. B. Armstrong,	Durban.
South African Cable Makers Assn.:	E. R. Smith, Sec.	Johannesburg.
Vincent & Pullar, Ltd. :	E. B. White,	Pietermaritzburg.
Vacuum Oil Co. of S.A. Ltd. :	J. Williamson,	Durban.
Wilson & Herd, Ltd. :	P. Butchart,	Johannesburg.

LADIES :

Mrs. A. T. Allinson; Mayoress of Pietermaritzburg.

Mesdames : Aldsworth; Cresswell; Coulthard; Dely; Dekenah; Dwyer; Gyles; Hassett; Harvey; Horrell; Jaggĕr; Marchand; Mail; Meteler-kamp; Mocke; Poole; Ralston; Rodwell; Sibson; Stevens; Wright and the Misses Ewer and Gyles.

OFFICIALS :

A. Mitchell (Reporter), Durban; E. Poole (Secretary and Treasurer), Durban.

PROCEEDINGS

OF THE

Thirteenth Convention

MONDAY, September 23rd.

The President, Mr. A. R. Metelerkamp (Bulawayo) in the Chair : I have very much pleasure in introducing the Mayor of Pietermaritzburg, Councillor Allison, M.P.C. We are very proud that he has consented to officially open our Convention. (Applause).

CIVIC WELCOME.

His Worship The Mayor of Pietermaritzburg (Councillor A. T. Allison, M.P.C.) said : It is with a sense of pride and pleasure that he welcomed to the City of Pietermaritzburg the Members, Delegates and Visitors of the 13th Annual Convention of the Association of Electrical Engineers of South Africa and Rhodesia. Pietermaritzburg is honoured by your presence and he sincerely trusted their stay here would be more enjoyable and their deliberation successful.

The business to be discussed is of the greatest importance to the whole country, and he had no doubt that they would achieve great things having far-reaching results. It is the duty of a municipality to supply cheap electric current, water and

transport, though the latter does not always form part of a municipal responsibility. Not many years ago electricity was considered a luxury especially in domestic service, but to-day the most modest householder enjoys the comfort and benefit of the advancement of electrical service as administered by municipalities.

In 1916 the late Sir William Hoy, General Manager of Railways, made the statement that he was considering the electrifying of a certain section of the railway. The first section in the Union to be electrified was from Glencoe to Pietermaritzburg which was accomplished in 1923. This in itself is an historic fact, and furnishes the means of speeding up the traffic to the Port.

Following up the electrification of the railway to Pietermaritzburg, the City Council decided to take its electricity supply from the Electricity Supply Commission, a step which has proved satisfactory. The Municipal Power Station was finally closed down on the 17th of November, 1928, after running continuously for 31 years. This entailed considerable work and expenditure, and meant the scrapping of our own generating plant. There is no doubt that local authorities will find it much more economical to purchase their current in bulk from the Electricity Supply Commission instead of generating it themselves. Another advantage of purchasing current from the Electricity Commission is that it means saving big capital expenditure on generating plant, etc., which eventually becomes obsolete.

During the 1917 Conference, held in Durban, a flying visit was made to Pietermaritzburg by the delegates. Those who were present on that occasion will be able to notice the great development that has taken place in this City. We certainly have some of the old trams, but these are now supplemented by a fleet of modern busses.

Before you leave you may be able to induce our Electrical Engineer to part with one or two of our trams as souvenirs (laughter) as we are at the moment considering the replacement of trams by busses.

At the 1919 Port Elizabeth Electrical Conference, Mr. G. H. Swingler, Electrical Engineer of Capetown, was the author of a paper on the "Registration of Electrical Wiring Contractors and the Licensing of Electricians", not only of the contracting firm, but of their respective employees. The good seed that was sown on that occasion has born fruit. It was also proposed on that occasion to widen the scope of membership, and this, he believed will soon become an accomplished fact. Again wishing this Convention a most successful session he had very great pleasure in declaring the Convention open and hoped that one and all, including the ladies, would have a very happy and interesting time.

REPLY TO CIVIC WELCOME.

The President : On behalf of the Association, I wish to express to you, Mr. Mayor our cordial thanks for the welcome you have extended to us and to say how charmed we are with your beautiful City. Our last Convention was held in the City of Salisbury, and these two cities are renowned for their progress, in fact they are the only two cities I know of where you get tomorrow's news the night before (laughter). In connection with the status of a City, we in Bulawayo are very jealous of this particular status, for we know that we are the most important town in Southern Rhodesia, though we are not a city. Again I wish on behalf of the Association—and I also speak for the ladies—to thank you for the welcome you have extended to us, and making it feasible for us to hold our Convention in Pietermaritzburg. (Applause).

APOLOGIES.

At the request of the President, the Secretary read the following messages of apologies for absence :—

From Dr. H. van der Bijl (Hon. Member) Chairman Electricity Commission :— "Regret inability to be present at you Conference but send best wishes for successful meeting and continuance of good work your Association has done in South Africa in bringing the amenities of Electricity to the people, even in the remote parts of our extensive Country."

From John Roberts (Hon. Member), Local Manager Electricity Supply Commission, Durban :— "Best wishes for the success of this Convention, congratulations also on the large number of members and delegates you have now attained compared with those attending our first, nearly 20 years ago."

Apologies and best wishes were also received from the following :—

A. M. Jacobs, E.S.C., Johannesburg.
Bernard Price, V.F.P. Co., Johannesburg.
Councillor Flemming Johnston, Durban.
Engineer, I.S.C.O.R., Pretoria.
Engineer, African Broadcasting Co. Pietermaritzburg.
Chairman, Certificated Engineers, Durban.
W. H. Bottomley, Electrical Engineer, P.W.D., Pretoria.

Municipalities of :—

Kimberley; Grahamstown; Vereeniging; Somerset East; Paulpietersburg; Barberton; Barkley East.

Members :—

F. C. D. Mann, Worcester; J. Rogers, Fort Beaufort; J. G. Davison, Port Alfred; J. Iverach, Grahamstown; G. H. Swingler, Cape Town; A. R. Campbell, Johannesburg; T. J. Coppin, Walmer; I. J. Nicholas, Umtata.

Electrical Trades :—

Henley's Tel. Works Co., Johannesburg; T. Barlow & Sons, Durban; Siemens (British) Durban.

CONFIRMATION OF MINUTES.

The minutes of the last Convention, which had been circulated, were then taken as read and confirmed.

The Secretary then read his annual report as follows :—

THIRTEENTH REPORT and BALANCE SHEET of the ASSOCIATION OF MUNICIPAL ELECTRICAL ENGINEERS or the Period Ending September 3rd, 1935.

Mr. President and Gentlemen,

I have the honour to present herewith the Thirteenth Report and Balance Sheet covering the affairs of the Association since the 1934 Convention held at Salisbury.

MEMBERSHIP.

The membership of the Association as by the last report and as at present existing is a follows :

	1934	1935
Honorary Members	3	3
Members	69	61
Associate Members	11	15
	83	79

Three new members have joined during the period, four have transferred to the class of Associate Members, others have resigned (some on retiring from Municipal service) while others must also be assumed as having resigned.

A further loss to our membership was caused shortly after our last Convention by the death of the late President, Mr. L. F. Bickell, of Port Elizabeth, which we deeply deplore.

FINANCIAL.

The financial position of the Association is still in a satisfactory position, though the result of the actual year's working shows a small loss, but our expenses were much above the average, due to abnormal printing and reporting costs, while on the Revenue side the outstandings are high, chiefly through members who are in arrear with their subscriptions, and the Balance Sheet shews that most of the arrears shewn in the previous year's Financial Statement are still carried on as they were not dealt with last year. The sales of Proceedings whilst being above the average does not shew the increase expected, but it is hoped with the increasing interest shewn by the Municipalities in the affairs of the Association, some of whom have given donations to our funds, that these sales will very much improve in future.

NEW RULES AND CONSTITUTION.

At our previous Conventions Municipal delegates have advocated that our membership ranks should be extended so as to admit the inclusion of the Councils owning the various Electricity Undertakings, as is the practice in Great Britain with our parent Association, and during the year this Council has had under consideration amendments to our Rules and Constitution with this object in view.

The proposition has been circulated among our members as well as the various Municipalities and has received very encouraging support, some Municipalities having even paid their subscriptions in anticipation of the proposal becoming effective.

The proposal, however, will come forward for approval at the Pietermaritzburg Convention and I feel sure its adoption will go a long way in making the Association rank more of a "live wire," besides being advantageous to the Councils owning Municipal electricity undertakings and their respective Electrical Engineers throughout the Union.

SECRETARYSHIP.

The decision made at the Salisbury Convention that continuity of office should be associated with the secretarial work in place of the past practice of an ever changing Honorary Secretary and Treasurer is a move in the right direction, especially as the work has quite outgrown the spare-time capacity of busy Municipal officials who have acted in the past.

At the close of my first year of office in this new capacity, I wish to place on record my appreciation of the confidence of the members of the Association by electing me to this office and my special thanks are due to the President, Vice President and members of the Council for their assistance throughout the period.

I am,

Mr. President and Gentlemen,

Yours faithfully,

E. POOLE,

Secretary and Treasurer.

3rd September, 1935.

ASSOCIATION OF MUNICIPAL ELECTRICAL ENGINEERS.

(Union of South Africa and Rhodesia).

REVENUE AND EXPENDITURE ACCOUNT FOR THE PERIOD

4th September, 1934 to 3rd September, 1935.

Expenditure	£	s.	d.	£	s.	d.
Typing and Duplicating at Port Elizabeth				7	10	0
Honorariums				13	13	0
Statistical Tables				10	0	0
Printing Proceedings				148	16	4
Reporting				35	5	0
Donation (W.P.C.)				5	0	0
I.M.E.A. Reports				5	12	4
Bank charges	4	17	7			
Less recovered	1	7	6			
				3	10	1
Secretarial Expenses—						
Salary	55	0	0			
Postages	14	3	3			
Tel. and 'phone	3	1	1			
Sundry	6	3	2			
Prtg. and Stationery	13	3	0			
				91	10	6
				£320	17	3

Revenue.	£	s.	d.	£	s.	d.
Subscriptions :—						
Collected (current year)	121	16	0			
collected (last year for current period)	1	1	0			
Outstanding	18	18	0			
				141	15	0
Proceedings				61	10	0
Donations				12	2	0
Advertisements				39	18	0
Statistical Tables				20	0	0
I.M.E.A. Reports				4	16	0
Balance, being Excess of Expenditure over Revenue transferred to Accumulated Fund				40	16	3
				£320	17	3

BALANCE SHEET AS AT 3rd SEPTEMBER, 1935.

Liabilities.	£ s. d.	£ s. d.
Subscriptions in advance		1 1 0
Subscriptions: Council contributions paid in advance		16 16 0
Accumulated Fund :		
Sept., 1934.	341 9 4	
Less loss current year	40 16 3	
		300 13 1
		£318 10 1

Assets.	£ s. d.	£ s. d.
Union Loan Investment		200 0 0
Cash at Bank		78 8 7
Sundry Debtors :		
Current year	18 18 0	
Balance, 1934.	21 3 6	
		40 1 6
		£318 10 1

E. POOLE,
Secretary and Treasurer.

I certify that I have examined the books and vouchers of the Association and that the above Revenue and Expenditure Statement and Balance Sheet are correctly drawn up so as to exhibit a correct view of the affairs of the Association, according to the information and explanations given and as shewn by the books.

J. C. JOHNSTON,
Chartered Accountant (S.A).

7/9/35.

Mr. Rodwell (Johannesburg): said the report was very satisfactory, except, perhaps, from the financial standpoint. No doubt, however, the financial position would improve during the next year, and he had much pleasure in moving the adoption of the report and balance sheet.

Mr. Horrell (Pretoria) said he had much pleasure in seconding.

Carried.

VOTE OF CONDOLENCE.

The President referred to the lamented death of one of their Past-Presidents, Mr. L. F. Bickle. A letter of condolence would be sent to his family, and as a mark of respect he asked all present to stand in silence.

MEMBERSHIP.

The Secretary read the changes of membership during the past year as follows :—

New Members :—

E. A. Behrens, Port Elizabeth.	W. Rossler, Ladybrand.
C. H. Dwyer, De Aar.	A. R. Sibson, Graaff Reinet.

Transfers to Associates:—

A. R. Campbell, Springs.	H. Purves, Boksburg Nth.
J. C. Delport, Barkley East.	F. E. Syers, Johannesburg.

Resignations :—

N. I. Beswetherick Umkomaas.	C. M. McComb, Springs.
R. Torr, Volksrust.	

ARREARS.

The President remarked that the next item was the question of arrears especially those of members who were in arrear with their subscriptions. It had been suggested that the names of those whose subscriptions were outstanding as at September, 1934, be removed from the register.

On the motion of Mr. Gyles (Durban), seconded by Mr. Macaulay (Bloemfontein) it was agreed that all arrears as at September, 1934, be

written off and the names of those whose subscriptions were in arrear at that date, be removed from the register.

HONORORIUMS.

It was decided that the auditors at Port Elizabeth and Durban be voted an honorarium of three guineas each.

ELECTION OF PRESIDENT.

Mr. Gyles (Durban) said he had much pleasure in moving that Mr. G. G. Ewer, of Pietermaritzburg, be elected President of the Association for the ensuing year.

In seconding, Mr. Horrell (Pretoria) said they had known Mr. Ewer for many years. This was the first time the Convention had been held in Pietermaritzburg, and he was sure that members would agree that they would be very pleased to have Mr. Ewer as their President, and in the event of his election he (Mr. Horrell) hoped that Mr. Ewer would have a very happy year of office.

There being no other nominations, Mr. Ewer was declared as having been unanimously elected President (Applause).

RETIRING PRESIDENT'S VALEDICTORY ADDRESS.

By Mr. A. R. METELERKAMP, A.M.I.E.E.
Town Electrical Engineer, BULAWAYO.

It is with deep regret that I have to record the loss to our Association in the death of our immediate past President the late Mr. L. F. Bickell of Port Elizabeth. Our deepest sympathy is extended to the relatives of the deceased.

In reviewing the year since our last convention, I have to report that few matters of major importance have come before the Council of the Association. As President my duties have not been strenuous, due to the untiring work of our Secretary, Mr. Poole. This Association is particularly fortunate in having the services of so capable and experienced a secretary, and before proceeding further I wish to express my sincere appreciation of the very valuable advice and assistance rendered me by him during my term of office. On behalf of the Association may I express the hope that Mr. Poole's experience will continue to be available and that he will pilot the Association for many years to come.

The Council of the Association, after due consideration, have decided to recommend certain revision to the Rules and Constitution. The object of these alterations is to extend membership to Councillor members. Councillor members will be the committee appointed by the Municipality or local authority controlling the electricity undertaking, and shall be represented by a member of that committee, present at the convention. As the chief object of the Association is to promote the interests of municipal electrical undertakings, it is the considered opinion of the Council that it will be in the mutual interests of local authorities and the Association to have direct representation from the various municipalities in the form of councillor members. This matter will be fully debated during the convention.

Our Secretary has drawn my attention to the increase in outstanding subscriptions. I am strongly in favour of enforcing the rules in this direction. Our finances are such that all subscriptions must be promptly paid if we are to function efficiently as an association. Too much time and money is spent in sending out reminders. Let us apply what is the most effective means of obtaining payment in all electricity undertakings,

after the final notice, "Cut off." This matter of arrears in subscriptions is never a very pleasant one. May I appeal to you all to play the game and "pay up."

Some Councillors, more especially those representing smaller municipalities, are of the opinion that these conventions take the form of a glorious outing. They are certainly very pleasant functions. but personally I sincerely hope they will never degenerate into picnics. During the formal and informal discussions much useful work is done for the benefit of the municipalities we represent. It has also been asked, "Why go to the expense of sending the engineer to a convention when a copy of the proceedings may be purchased for five shillings?" If the majority of municipalities formed this view no further conventions would be held. As a result of my own experience I consider these conventions are of the greatest benefit to the representatives of the smaller municipalities.

Coming to the all-absorbing topic of the growth of electrical ventures in South Africa and Rhodesia, most undertakings in Southern Africa are developing at the same extra-ordinary compound rate. It has been said that this happy state of affairs cannot continue, as sooner or later saturation point must be reached. Saturation point is however, a long way ahead when we consider that there are Canadian towns with twice the consumption of many of our well developed towns.

It had been pointed out on many occasions that nearly all future load-building must come from the domestic consumers. In this connection one of the chief considerations is the consumer's monthly bill, or the **average price per unit** paid by the consumer. Numerous articles have appeared in the official **organ of the Association**, the S.A. Electrical Review and Engineer giving valuable data in connection with domestic consumers. When examining these figures, it will be noted that the lower the tariff or average charge to the

consumer the higher the consumption and the revenue, e.g., average revenue per domestic consumer in Durban is 20/8d., which is 5/– higher than that of any other town, whilst the average consumption is 277 units which is double the average of any other South African town except Cape Town.

The general growth of load is exemplified by the erection of super stations in South Africa, viz : the Klip generating station with an ultimate capacity of 350,000 kw., and the contemplated station at Cape Town of 200,000 k.w. Of particular interest to engineers is the comparison of the steam pressures and temperatures. The Klip station will operate at 355 lbs. per sq. inch and 750° F. as compared with the Cape Town station at 600 lbs. per sq. inch and 800°F. It is surmised that the cost of coal is the chief factor which decided these details.

A report on Electric Shocks from Earthed Apparatus has been submitted to The British Electrical and Allied Industries Research Association by H. C. Taylor (M.Sc.). The rendering of this report, and the fact that comprehensive experimental investigation is being carried out by that body, is of particular interest to members of our Association. Though the number of fatal accidents due to inadvertent contact with electrified apparatus is low as compared with accidents under other heads, every endeavour should be sought to reduce these to an absolute minimum.

No outstanding advance has been reported in the increase of steam pressures or temperatures, or the development in power station practice in the attempt to improve the overall thermal efficiencies of stations. Perhaps, in this direction, the Russian thermal-electric stations are of interest. The supply of hot water for heating of buildings etc., within a radius of as much as two miles by the use of passout turbines has been undertaken by these stations, thereby increasing

the efficiency to over 58%. It is difficult, however, to imagine this practice being successfully adopted in South African towns.

In Great Britain considerable attention has been given lately to the question of providing underground E.H.T. feeders in towns to cope with the increase in the demand for electrical energy. South Africa has shown considerable foresight in this direction, as several of our larger towns have had underground 33 K.V. feeders for a number of years. It is essential that we fully investigate the higher voltages when considering cable feeders to meet the increasing loads, so as to avoid being in the position that many D.C. undertakings were in prior to changing over to A.C.

The question of thermal storage is being investigated by the Electricity Supply Commission for the Congella Station, and it is hoped that the Commission will give our members details of the results and the benefit of their valuable experience at some future date.

In the strong combination of Maritzburg and Durban representing our President and Secretary, the Association may look forward to a most eventful year, during which a great deal of useful work will be performed. It is now my pleasant duty to wish Mr. Ewer every success during his term of office.

PRESIDENT'S ADDRESS.

G. G. EWER, D.S.O., T.D., M.I.E.E:,
City Electrical Engineer and Tramway Manager,
Pietermaritzburg.

Gentlemen

I desire to express my sincere appreciation and thanks for the honour you have conferred upon me in electing me President of the Association. I feel that this office is one of some importance

in our profession, and one which entails considerable responsibility, particularly this year, which may be the first under a revised constitution. This is the thirteenth Convention of the Association, and this fact may lead some members to consider that it may be a troublesome time. However, I do not anticipate this myself, and look forward to much useful work being done at this Convention, and during the ensuing year.

I should now like to say a few words of welcome to Members, Delegates and Visitors. His Worship the Mayor has already welcomed you officially, and I should like to add to his remarks my personal wish that you will all enjoy your stay in this City, placed as it is in such beautiful surroundings. It is the first time that the Association has held its Convention here, and I trust that you will all find Pietermaritzburg worthy in every way. Besides the scenic beauties of the City, and surrounding country, there are several local industries which are of interest, and visits have been arranged to some of these. If any delegates desire to inspect factories or other places of interest not included in the official programme, or any of the Electricity Department's Sub-Stations or Workshops I shall be happy to help them in any way possible. Councillor Delegates interested in Native Affairs may like to visit the Corporation's Native Village or new Native Beer Hall. This can also be arranged if desired.

As mentioned in my opening remarks, the revised Constitution of the Association will be brought before this Convention for approval. The new Constitution provides for the admission of Local Authorities as Members. This is a step which has been discussed by the Association for some years, and it will bring it into line with the parent Association of Great Britain, and with the Association of Road Passenger Transport Undertakings of South Africa. I know that many Councillor delegates have strongly advocated this change for several years past, and I hope that it will lead to a considerably improved status for the

Association, and to the Association becoming an even greater asset to its Members than in the past. To those of us who have attended the Conventions from time to time, there is no doubt that they have proved of great value to Electrical Engineers controlling the generation and supply of electricity throughout the Union and Rhodesia, and the local authorities owning the Electricity Supply Undertakings, have of course, shared in the benefits gained by those Engineers who have joined the Association. It seems, therefore, that the proposals which I hope will be agreed to this morning, will be to the mutual benefit of all Electricity Supply Undertakings in this Country.

I trust that the delegates representing those Councils which have, so far, not agreed to join the Association will return to their respective towns after the Convention, and persuade their Councils to join, and so strengthen us in our efforts towards efficiency in the Electricity Supply Undertakings of this Country.

Before proceeding with the normal business of the Convention, I should like to refer briefly to the rapid progress of the Electrical Industry recently. Looking through recent reports I find that it is stated, that more than half of the industrial machinery in use to-day, is obsolescent in part, because of recent improvements in electrical equipment made possible by research work and advanced engineering. I should like to mention a few of the recent developments and inventions. Some of these do not concern Municipal Electricity Undertakings, but they are mentioned to indicate recent progress in Electrical Engineering generally.

The modernization of switching equipment is continued, and all types of cable have been improved, particularly in insulation and finish.

Ships are now being built on which practically every ship-board auxiliary requirement is met by the use of A.C. Motors. In addition to the advantages of simplicity in design and installation

effected by the adoption of A.C. auxiliary drive, notable reductions in weight have been made—an important factor in ship construction.

New types of streamlined electric locomotives are now being built, capable of speeds up to 100 M.P.H. For street transportation the use of improved types of Trolley Buses is now being extended, both overseas and in this Country.

In addition to their use for household and commercial refrigeration, and in air conditioning, refrigerating machines are now applied to such diverse uses as the operation of steel tempering tanks and mercury-arc rectifiers.

A 400,000 volt X-Ray tube has been developed, energized from a voltage doubling circuit with the transformer centre-earthed, thus requiring only 200,000 volt insulation to earth. Owing to its small size and low voltage to earth, no special building is required for its installation in the hospital, an ordinary room in most instances providing sufficient high-voltage clearances. This equipment produces large quantities of the short-wave radiation desired in cancer treatment, and also increases by 100,000 volts the range of industrial radiography.

A practical ultra-high-frequency two-way radio communication system has also been developed, which permits police cars to maintain contact with their districts and headquarters while actually patrolling. The car equipment includes transmitter, receiver, loudspeaker and telephone. Many new instruments have been devised for use in the laboratory, on power systems, and in industry, including an ingenious dielectric test bridge which makes possible the predetermination of approaching insulation break-down. Other new instruments include an Audio noise Meter, and an automatic sound recorder.

A device for testing the continuity of the enamel on Magnet wire automatically passes a predetermined length of wire through a mercury bath, with a voltage applied between the copper and the mercury. The number of imperfections in this length of wire is recorded on an electrical counter.

A magnetic detector has been arranged to protect sugar-mill machinery against tramp iron in the cane.

Considerable progress has been made in the study of lightning and its associated phenomena; but before the problem of lightning protection is completely solved, more must be learned of the nature and characteristics of natural lightning. Considerable study of natural lightning has been made recently, and several new instruments to assist in this study have been developed, including an improved surge-crest ammeter, by means of which currents have been recorded as high as 83,000 Amperes in a transmission tower affected by a lightning stroke.

Another new invention is an electrical method of freeing air of dust and smoke particles. By employing a "precipitator," which passes an electric current through the air the atmosphere is completely cleansed, even the smoke content of the air—which is hardly affected by ordinary filtering—being removed.

New types of lamps, including the coiled-coil lamp, and gaseous discharge lamps, are now available, which assist us to provide more efficient illumination for all purposes.

A new photoflood lamp, somewhat smaller than the movieflood lamp, gives four times the light output of the original photoflood lamp. It has a consumption of about 1,000 watts, and an average life of about 10 hours. It gives about two and a half times as much light as any other lamp of equal wattage, and is of particular value for close-up work in motion-picture photography, as well as being useful to the commercial photographer.

Dealing now with our own particular Industry, i.e., the generation and supply of electricity, I find that for the year 1927-28, the total amount of current consumed throughout the Union was 1,806,854,053 units. This increased to 2,462,191,391 units for the years 1932-3—the latest year for which official figures are available. This is an increase of 36.27% in five years. During the same period, at Pietermaritzburg, Electricity sold per annum increased from 4,693 221 units to 10,977,449 units—an increase of about 134% in five years. From 1927/28 to 1934/35 (seven years) the units sold per annum at Pietermaritzburg increased from 4,693,221 to 13,988,042 an increase of approximately 198%. I know that other Undertakings have similarly increased their outputs and I think that you will agree that this is a very healthy state of affairs.

During the last Corporate Year 302 additional Cooking Stoves and 255 additional Refrigerators were connected to the Pietermaritzburg mains, making totals of 1,792 stoves and 828 Refrigerators connected at the end of July. This rate of progress is being steadily maintained in Pietermaritzburg and many other towns.

There is still considerable scope for further development in the use of electricity in this Country. The average consumption of electricity by the white population of the nine principal towns of the Union and Rhodesia is at present about 782 units per head per annum. Durban has the highest consumption—1,408 units per head of the white population. It is stated that the smallest household will require at least 1,500 units per head per annum for lighting, cooking and ironing, and two or three times as much when space heating and water heating are carried out electrically.

It will therefore be seen that most of us can look forward to at least doubling our present outputs before anything like saturation point is reached.

This brief summary brings us to a realisation of the great field in which Electricity and Electrical Engineering play their part, and to the very great influence which they exercise in all branches of industry, and in the homes of the civilized world. The use of Electricity is now almost universal, and it behoves us all to do our best to still further advance its utility and efficiency in every possible way within our power. We shall have an opportunity of discussing some of the recent developments at this Convention, and of seeing some of the latest types of electrical appliances at the Exhibition which is being opened in the City Hall to-morrow.

With the assistance of the British General Electric Company, Siemens Bros. & Co. (British) Ltd., and the S.A. General Electric Co., who have kindly loaned the necessary Lanterns, Flood Lighting Fittings and Lamps, a demonstration of Street Lighting and Flood Lighting has also been arranged. These you will be able to see every evening during the Convention.

I trust that all present at this Convention will return to their various towns well satisfied with what they have gained during these few days.

I think you for your attention during these few remarks.

Mr. Rodwell (Johannesburg) said he felt sure that he was voicing the sentiments of all present when he remarked how pleased they were with the new President's address. (Applause). He would also like to add his thanks to the Mayor for his very kind welcome. He was sure that in their President they had a man of vision and an energetic worker who would guide the Association through the coming session with credit, not only to himself, but to the Association. (Applause).

The President's address was stimulating in its interesting review of engineering progress, and as electrical engineers, engrossed in their particular

branch of the profession, were apt to forget that their confreres in other engineering spheres were moving with the times in this accelerated age.

The electrical development of Pietermaritzburg, as outlined by the President was indicative of progress equal to that of other important centres of the Union, and Mr. Ewer was to be congratulated on his progressive policy in the administration of his department. Pietermaritzburg, as mentioned by the President, was indeed set in beautiful surroundings, and after completing the programme of visits, they would return home with very pleasant recollections of their first official visit as an Association to that city. They thanked Mr. Ewer for his address, and wished him a successful year of office. (Applause).

NEW RULES AND CONSTITUTION.

Mr. Horrell (Pretoria) moved that the Rules and Constitution as has already been circulated, be adopted in principle. The matter has been under consideration for some years now and similar rules had been adopted in England with great success. Council members have attended our Conventions in the past but have had no power to vote.

Under the proposed new constitution both their interest and power in the Association would be increased. He assured them that the City Council of Pretoria will support the matter wholeheartedly and felt that most other towns will do likewise. He certainly felt that the new proposal will lead to greater power for the Association and to the accomplishment of more work than has been done in the past.

In seconding, Mr. Rodwell (Johannesburg) remarked that Johannesburg had sent in its contribution. The whole position had been explained so lucidly that there was no need for him to enlarge upon it.

The motion was then carried unanimously.

On the suggestion of the President, the Secretary explained that the following minor additions to the Constitution, had that morning been approved of by the Council.

CLAUSE 3. All "All Hon. Members and Members of the A.M.E.E. shall ipso facto become members of the A.M.E.U. and existing Associate Members shall be eligible to transfer to class of Associate."

CLAUSE 4 (b). Add : after the words—'The Member':—"whose Chief Electrical Engineer shall have qualifications acceptable to the Council of the Association."

CLAUSE 4 (c). Add, after the words 'Local Authority':—"and who has had a thorough training in Electrical Engineering and is otherwise acceptable by the Council of the Association."

CLAUSE 6. Add, after the words 'due and payable' :—"anually on the 1st day of September."

CLAUSE 6 (c). Add, after 'resigns from Membership':—"The Engineer Membership contribution shall be two (2) guineas."

On the motion of Mr. Gyles, (Durban) seconded by Mr. Macaulay (Bloemfontein), the Rules and Constitution, as circulated, together with the additions were then unanimously agreed to, the Rules and Constitution reading as set out on pages 6 to 11.

COUNCILLOR MEMBERS.

The President mentioned that the following had decided to join the Association and others, he added, were considering the matter.

Bedford.
Bloemfontein.
Cape Town.
Cradock.
Durban.
East London.
Eshowe.
Fort Victoria.
Johannesburg.
Kimberley.
Klerksdorp.
Kokstad.
Krugersdorp.
Mafeking.
Pietersburg.
Pietermaritzburg.
Port Elizabeth.
Paarl.
Pretoria.
Roodepoort.
Salisbury.
Springs.
Somerset East.
Umtali.
Walmer.

merce and Industries in a proposal to organise a combined deputation to interview the Minister in Pretoria.

It transpired that both these bodies had the matter of railage rates on coal under consideration, but they were definitely of the opinion that it was useless seeing the Minister unless the deputation represented the whole of the influential bodies in the Union. He proposed therefore that this Convention should pass a resolution requesting the various bodies to participate in a deputation to interview the Minister in regard to this matter.

The President said it was really a matter of reaffirming a resolution of last year. If the Convention would agree to the same members of the sub-committee carrying on he felt sure they would look after the interests of the Association.

This course was agreed to.

At the request of the President, the Secretary read the following extract of a letter from the Town Clerk of Eshowe :—

> "It is noted that one of the matters being dealt with by your Association is "Railage Charges on Coal." I am instructed to reuest that in conjunction with this you also investigate the railage charges on Diesel fuel oil, when this is used for a municipal electricity supply. The railage charges paid by the Board's Electricity Department for fuel oil amount to 38.4% of the cost of the oil, and it is considered that this is excessive, particularly since the oil forms the basis of an essential public service. It may be possible, through your Association, to make strong representation to the Railway with some success, and I shall be glad to know what can be done in this matter."

Mr. Sparks (Pietersburg) warned the Convention that it was treading on very dangerous ground in asking for cheaper rates on fuel oil. They had just had an instance in his district, where the railage represented 33 per cent. of the cost of the oil. Those in the country districts had to face a tremendous competition from oil. The Con-

vention, in his opinion, should think very carefully before it dabbled in trying to reduce the railway rates on oil. They should foster their own industries first.

The President: Perhaps we had better work on the lines of getting preferential rates on fuel oil for Municipalities.

Mr. Meterlekamp (Bulawayo) thought they should keep the two things separate.

Mr. Ralston (Dundee) said he brought this question up at the 1924 Convention, when they discussed the rates on coal. The Government gave subsidies to other industries but for coal which was so essential to the country generally, nothing was done.

Mr. Councillor Phillips (Salisbury) agreed that oil should be cut out of the question.

Mr. Milton (Electricity Supply Commission) remarked that the Electricity Supply Commission, in view of its position vis-a-vis the Administrators of the several Provinces in connection with Municipal electricity supply schemes, had a wide knowledge of the competition that exists between coal and oil fuels, more particularly in the smaller Municipalities.

In many districts it was found very difficult for electricity undertakings to compete with crude oil prime movers. As with coal, a fairly large proportion of the cost of oil to the consumer was made up by the railage. Unlike the case of coal, however, the majority of the balance of cost to the consumer was money which left the Union. In dealing with the question of preferential railway rates on oil, one must bear in mind that a company had been formed to extract crude oil from local oil shales.

Mr. Milton believed that this oil would be used to dilute imported oil for the purpose of providing fuel for internal combustion engines. Even with the local industry in mind, it was questionable whether a preferential railway rate on oil would be in the best interests of the country, and in the circumstances he, too, supported Mr. Phillips and felt that the discussion in regard to reduced rates should be confined to the question of rates on coal.

The President thought that perhaps it will be best to refer this back to the council for such action they may think advisable.

This suggestion was adopted.

ELECTRICITY SUPPLY REGULATIONS.

Reporting on behalf of the sub-committee on the above subject, **Mr. Rodwell** (Johannesburg) said this matter, which was something of a hardy annual, was dealt with at the last Convention. It was fully described on pages 203-4 of their last proceedings. It would be remembered that two years ago they appointed a sub-committee to go into the matter, consisting of Mr. Horrell, Mr. Wright and himself. The work had gone on, and a committee was appointed in Johannesburg with other representative bodies.

Under the very able chairmanship of Mr. E. T. Price of the Electricity Supply Commission numerous meetings were held and a great deal of useful work was done. He did not have a lot to do with it personally, but his assistant assured him that the matter was gone into thoroughly, and it was decided to make certain amendments which were felt to be necessary in order to incorporate the smaller municipalities. Mr. Price found it necessary to proceed to Europe and was unable to proceed with the final compilation of the report, which was, however, now in hand. While this had been a long drawn out matter a tremendous amount of work had been put into it and the various submissions were now being dealt with.

Mr. Milton (Electricity Supply Commission) said the position in regard to these regulations had been explained very clearly indeed by Mr. Rodwell. The draft regulations had been fully discussed and it was agreed to form a special committee to go into the question.

This committee had completed its functions and had studied the draft regulations of the Commission in detail, making several suggestions as to the amendments to these regulations where considered necessary. The committee had left it to Mr. E. T. Price to take the necessary steps to have the draft cleaned up and the final document prepared for the approval of the committee. Mr. Prices's work had been delayed by reason of the wish of the committee that the latest regulations of the I.E.E. of Great Britain should be awaited and studied to see whether there were any possible additional points which might be included in the final draft, and unfortunately Mr. Price had had to proceed overseas before he could see this work through.

During Mr. Price's absence, matters had been left to him (the speaker) but, unfortunately due to pressure of work, little progress had been made. The Commission had every hope that at an early date the regulations would be re-drafted in final form for submission to the aforementioned committee. The revised regulations would comprise a voluminous document, the printing of which would probably be an expensive item.

The suggestion had been made that the draft regulations should be issued to all members of the Association of Municipal Electricity Undertakings. Whether or not the Commission would be prepared to print the regulations for circulation he could not say, but it was very doubtful that the Commission could justify the expenditure. Earlier, Mr. Milton had stated that the documents were voluminous; this remark should be qualified, as considerable work was being done in order to reduce the space of the regulations and make the document suitable

for easy reference. In draft, some points were dealt with in several sections of the document, and an effort was being made to bring reference to any particular subject into one position, in order that the subject would be fully covered without continual cross-reference to several sections.

Mr. Rodwell (Johannesburg) thought their thanks were due to the Electricity Supply Commission for the enormous amount of assistance it had given and to Dr. van der Bijl in particular. (Applause).

Mr. Horrell (Pretoria) asked what is to be our future procedure in regard to these regulations? Are they to be binding on all electrical undertakings when once they have been adopted? In the past we have not succeeded in obtaining uniformity since everyone has his own ideas on the subject.

It has to be admitted that in regard to some regulations different conditions obtain at the coast from those elsewhere and he hoped therefore that the new regulations would provide for this and so avoid a reversion to the present chaotic state.

Mr. Milton (Elec. Supply Com.) stated that the intention of the committee investigating the draft regulations was that they should have universal application and that they should ultimately be adopted as a Government measure to apply throughout the Union. The avenues through which this end would be approached, had not yet been fully considered by the committee but this would be done when finite regulations were ready.

As regards the commission, it was laid down in the Electricity Act as to how the Commission's regulations would become operative and Mr. Milton pointed out that when the Commission went forward in the manner prescribed by Law, once the Commission's regulations were approved, they would apply to the Commission's undertakings in three of the four Provinces, namely, the Transvaal,

Natal and the Cape. As technical adviser to the Administrator, the Commission would obviously be in the position of recommending the adoption of its own regulations by the Administrators of three of the Provinces, and it was not likely, if asked to advise the fourth Province, that any different regulations would be recommended. In this way, therefore, it was probable that there would be no difficulty in having the regulations applied provincially.

The next step, namely, to have the regulations made Union Law should not be difficult if standard regulations were in force in the four Provinces. As regards the question as to the application of such regulations in small as well as large Municipalities, Mr. Milton stated that the regulations endeavoured to deal with those general points which should be enforced in all undertakings, whether small or large in the body of the regulations and that provision was being made in the form of appendices to allow of the enlargement of the regulations to suit the requirements of individual Municipalities, having regard to the size of the undertaking, to any special features and to its position say in relation to the coastal belt, etc.

The committee was satisfied that the needs of all Municipalities would be very readily met by the proposed draft and its form of application.

Mr. Wright (Benoni) said no one but those who had been on the committee could appreciate the amount of work put into it. He was appointed a member of the committee after it was first inaugurated three years ago. Meetings were held almost every week, and it was found as they went on that it was extremely difficult to get things straight. He would like to move that the Association subsidise the Committee in order to enable it to print sufficient copies of its report so that each member might get a copy.

The President said they all appreciated the work the Committee had put into this very important matter. At the same time it was a very big job and for that reason they must not hurry it. He suggested that the question of printing the regulations be referred to the Committee.

This suggestion was adopted, and it was also agreed that the Committee should be asked to carry on.

RELIEF OF RATES.

The Secretary reported on the question of the relief of rates. Last year, he remarked, it was mentioned that it had not been dealt with. He had circularised all the town clerks and had received a few replies to the effect that the matter was being considered. He did not think that there was one reply indicating definitely that they were prepared to fall in with the proposal for a reduction of rates. The matter was one of many years standing, the councils never having taken the Association's resolutions seriously. In the circumstances he feared there was little to be achieved by further resolutions.

Mr. Sparks (Pietersburg) said one had to be very careful how a resolution on this subject was worded and sent to the Town Councils. As a matter of fact the Chairman of their Finance Committee took umbrage at what the resolution contained until he (Mr. Sparks) explained the Association's point of view. The Association should be careful to make it more in the nature of a suggestion than a matter to be agreed upon. If the resolution were worded differently he thought it might have had a better effect.

In reply to Mr. Eastman, the President said he had asked the Secretary to look up the resolution.

Mr. Milton (Elec. Supply Com.) asked if the Association had been approached in regard to legislation on the matter. He believed a move had been made in some quarters to introduce legislation limiting contributions to relief of rates.

Mr. Horrell (Pretoria) suggested that the matter be referred back for consideration by the Council. There appeared to be a general feeling that they should have a Betterment or Reserve Fund to which a certain percentage of the excess revenue should be contributed each year, leaving the balance to be applied to the relief of rates.

Without such a fund it meant that when new plant is purchased to replace plant which had become obsolete new capital had to be applied thus incurring additional interest charges while the old interest charge had necessarily to continue until the expiration of the original loan period.

The position would be quite different if they had a Betterment Fund.

The President suggested that perhaps the Councillor delegates would like to express themselves freely on the question.

Mr. Councillor Allison (Mayor of Pietermaritzburg) said that until 1930 in Natal it was not possible to apply profits from electrical undertakings for the relief of rates. Other means were used to ensure that these profits should not be lost. He was sure there was no legislation being brought before the Provincial Council in order that these profits might not be taken in aid of rates. Since 1930 Pietermaritzburg had had about £20,000 paid into revenue to keep the rates down. He was pleased to hear Pretoria speak about a Betterment Fund as in Capetown. They had been discussing this matter in Pietermaritzburg for a very long time, and had not got very far. He saw the necessity for it and hoped their Town Council would tackle the matter. The position might arise in which after many years they

wanted to change over and they found that they had an enormous amount of obsolete plant to pay for, and that if they had a betterment fund it would provide a way out of the difficulty. He was glad in this connection that they had agreed to Town Councils becoming members of the Association.

Mr. Councillor Dely (Pretoria) said it was very difficult to generalise the circumstances in each case because they were all so different. In Pretoria they had a large body of flat dwellers, excellent people but they had a way of escaping payment of rates. They got off 'scot free,' and the whole burden was loaded off on the ratepayer. As soon as there was a proposal to increase the rates by say 2d. there was an outcry. Taking it all round, he did not think it advisable to pass any definite resolution. By means of a Betterment Fund they could keep within certain limits, and it would be a good way of camouflaging the position. (Laughter).

At the request of the President, the Secretary read the resolution passed by the Convention at Port Elizabeth in 1933.

Mr. Councillor Fowkes (Cape Town) felt somewhat diffident in commenting upon what was after all a very delicate subject, particularly in view of the fact that they had had no intimation that this question was going to be discussed. The matter was one in which he was deeply interested. Whatever the amount of profit that might be made out of any electricity undertaking, he thought it would generally be conceded that full provision should be made for depreciation and obsolescence of plant. In these days they were moving forward at a very rapid rate in regard to electrical matters, and they scarcely knew from one year to another what they might have to face.

The question of a contribution to rates was naturally closely related to this question of depreciation for it was obvious that the more taken from the profits of an undertaking for the relief

of rates, the less amount would be available for depreciation. There was also the danger that if the finances of a Town Council were in such a state that there was a danger of an increased rate, there might be a recommendation that this should be avoided by taking more from the electricity undertaking.

It seemed to him that they should have some legislative authority under which it would be possible to restrict in some way the amount that might be taken for the relief of rates in any one year. This matter was very important and he thought that perhaps it would be best for the Council to consider it again and bring a definite recommendation at the next Convention. (Applause).

Mr. Councillor ——?—— (—) thought it absolutely essential that a town council should have every opportunity of trading and benefitting the rates. He was of opinion that the Convention should confine itself to its own particular business and concentrate upon the question of a Betterment Fund. Feeling throughout the country was that a municipality should not be entitled to 2½ per cent. but 5 per cent. or 6 per cent., for the purposes of a Betterment Fund.

Mr. Councillor McLean (Port Elizabeth) suggested that the Association should not send any wishy-washy resolution to the Town Councils. As a Town Councillor he knew quite well that this was considered to be a matter of policy by the Town Councils. It was a matter of policy, but that was no reason why the advice of the men concerned should not be taken.

There was one principal of Municipal enterprise which should never be forgotten : the object of every Municipality should be NOT to make a profit. That of necessity meant that if a profit were made, the people who made it should get it back again.

Unless he was mistaken the system under discussion was first introduced in Durban, simply because they made a good profit out of their trams, etc., being used by visitors. The City Council of Glasgow tried time and again to get the profits made from their trams for relief of rates so much so that the Tramway Committee reduced the fares until passengers could travel three miles for a halfpenny.

Last year Port Elizabeth gave £25,000 to the relief of rates and one of the principal firms to benefit was a private gas company, which was in direct competition with the electrical undertaking. (laughter).

He considered that the Association should pass a resolution expressing what it felt, namely, that if there was to be a contribution to the relief of rates it should be very small indeed and not to the extent adopted to-day. (Applause).

Mr. Meterlekamp (Bulawayo) said he had a copy of the circular sent out by the Association in regard to the point under debate. There was nothing whatever in it to suggest that the Association wished to dictate in any way. It simply pointed out what had been done in Great Britain.

Mr. Ralston (Dundee) wondered whether any of those present favoured a pole rate.

Mr. Gyles said that in Durban they not only contributed to the Relief of Rates, but were charged 1/- per pole per month as ground rent.

Mr. Gregor (Standerton) said that the Standerton Electricity Department did not pay any rates or dues for the following :—

(a) Power Station buildings—plant and site.
(b) Sub-station buildings—plant and site.
(c) Poles erected in towns.
(d) Underground cables.

Any loans raised to finance electricity undertakings were backed by the town itself and he thought it quite fair that certain of the profits of electricity undertaking should be used so that rates may be lowered. He also felt that a certain amount of the profits should be put aside as an emergency or reserve fund.

Seeing that the financial side is controlled by the Treasurer's department more headway would possibly be made by having the matter discussed by the Association of Municipal Treasurers. If it were not discussed at their meeting it certainly would be when brought before them at the Council's committee meeting. In nearly all undertakings the estimates were the outcome of several discussions between the Engineering and Treasury departments and he felt sure that the Engineers must have the co-operation of the Treasurers before they could hope to accomplish anything in this important matter.

The question is frequently asked who foots the bill when the electricity department shows a loss. There are many stations showing a loss to-day. In the Free State a percentage of the income is put aside into a depreciation fund. This fund can only be used to replace damaged or broken parts. This fund as it stands appeared to him not to be sound but should be extended to include the purchase of plant and materials for any extensions whatever, either in the station itself or on the mains and distribution.

Mr. Ross (Potchefstroom) contended that each town would have to treat this matter according to local conditions. What is applicable to the large centres could not be applied to the smaller towns, where probably only a third of the ratepayers use the electric current. In such cases it would be unreasonable to appropriate any moneys from the Electricity Department for the relief of rates.

In his own case any surplus is used for extensions to the scheme or, passed on to the consumer in the form of reduced tariff.

Mr. Councillor Allison (Mayor of Pietermaritzburg) said there were several aspects which had not been touched upon. One was that if an electricity undertaking made a loss, how was it to be made up, and from what source? The reply was out of the rates. That being so was it not also fair and reasonable that the rates should share any profit? Speaking as a provincial councillor, it had come to his notice that far too often municipalities, when borrowing money, got it for a long term of from 40 to 50 years. If the period were 10 or 20 years it would mean that repayment would not be based upon such a long number of years.

On other occasions it was found that things were charged to Capital Expenditure which could very well come out of Revenue, and in many cases towns were saddled with high Capital Expenditure per head of the population. He maintained that if a Fund is to bear a loss, it should also on certain occasions have the privilege of sharing any profits. (Applause).

Mr. Eastman (Cape Town) stressed the importance of members viewing the question under consideration from the standpoint that electricity supply was an essential service. It was in fact just as essential a service in a large town as the water supply and sewage systems and there should, therefore, be no more justification for charging a pole rent for electricity mains and services than for charging wayleaves for water and sewage mains. If such a charge were made for poles and electricity mains it would, in his opinion be an opportunist way of raising money. The question of Electricity Undertakings establishing a Betterment Fund was discussed by the Association many years ago, and it would be remembered that that body was instrumental in getting a standard form of Municipal electricity accounts approved by the four Provincial Councils for use throughout the Union. Apparently, however, a number of Municipalities had not yet adopted this standard system of accounting which provides for con-

tributions from net revenue account being made to sinking fund, renewals and obsolescence fund, reserve and betterment fund. As an example of the usefulness of the betterment fund in Cape Town he stated that its existence had made it possible, without raising new capital for the purpose, to finance a hire purchase scheme which had resulted in an increase of sales of electricity for domestic uses from 12,000,000 to 75,000,000 units in the last five years. Leaving aside the question of equity of the relief of rates from profits by the Electricity Undertaking he held that the Undertaking as a whole would undoubtedly be handicapped in its development if all profits, or the greater portion of them, were relegated to the relief of the general rates so that a betterment fund could not be established to tide the Elecericity Undertaking over short-period bad times or to finance the development of the Undertaking or deal with the question of renewal of obsolescent plant without raising additional capital.

Mr. Milton (Elec. Supply Com.) supported the views expressed by Mr. Eastman. He stated that there was one aspect, however, which was apparently overlooked by Councillors and Engineers alike, although it was evident that some of the wiseheads of the country had seen the light. In other countries the Governments had come to regard electricity and its supply as a national asset and in view of the essential service aspect had introduced legislation controlling the supply of electricity. These other countries had been handicapped by the extensive and powerful private interests handling the supply of electricity.

For this reason the question of electricity supply control varied considerably as between the several countries which had adopted measures in this direction. For example, in the case of America, profits were limited, while in the case of Great Britain the problem had been tackled by means of the introduction of the "Grid" system and "Selected Stations." It was evident that South Africa had appreciated the difficulties with which

these other countries of the world had been faced and had realised that unless the same difficulties were to be encountered in this country, legislation should be embarked upon immediately.

In framing the Electricity Act of 1922, the Union Government had fully appreciated the national aspect of electricity supply. At that stage it would appear that it would have been difficult for the Government to take steps to control electricity supplied by Municipal undertakings other than to restrict a Municipality's operations to its area of jurisdiction.

Whilst the Government very evidently regarded electricity as a national asset, Municipal Councillors in particular appeared to be blind to the importance of electricity supply as a Municipal asset.

The Electricity Act was designed to ensure that electricity was available at cost to all and sundry, and the items which might be regarded as reasonable cost were definitely defined. An abundant and cheap supply of electricity was accepted as essential for the progress of the country as a whole, and it was not a far cry to apply the same argument to the development of the Municipality.

The question of a Municipal Council being entitled to look to its electricity undertaking for some contribution to relief of rates was decidedly debatable. There were a large number of people who felt that a Municipality should be entitled to some recompense as it was claimed that the Municipality ran certain risks in connection with its electricity undertaking, the medium of recompense being through the Municipal General Fund Account into which all profits from the electricity scheme should be paid.

As regards the risks referred to, it was argued that in the event of an electricity undertaking operating at a loss, the loss was borne by General Fund Account, and further the rates were pledged by the Municipality as security for the loans raised

in respect of electricity undertakings. The position might be met if a Profit and Loss account were opened for the electricity department which would then show the extent to which the electricity department was financed from General Fund when losses were incurred and a charge could be made interdepartmentally for such financial assistance as might be required. Later when the undertaking commenced to obtain profits, these profits could be used to offset previous losses.

The main point, however, of the discussion was the utilisation of profits towards relief of rates and assumed therefore that the undertaking was operating at a profit. Where profits were made by the electricity department it was obvious that electricity was not being used to the fullest possible extent because it was more expensive than it should be.

One often heard the argument that if profits were not contributed to rates, it would mean an increased rate and that the ratepayers in the circumstances would not permit a decrease of the contribution from the electricity department.

After all, rates as raised by the Municipality were intended to provide an equitable distribution of the Municipality's expenses amongst the property owners benefitting from the expenses and the distribution of sales of electricity and therefore profits arising therefrom did not necessarily coinside with the incidence of the town's rates. This distribution was extended to the residents by the larger ratepayers through the medium of the monthly rental.

As regards the town as a whole, he could not see how the position was in any way altered by a contribution from the electricity department towards relief of rates in comparison with a decreased income due to lowered tariffs and an increase in the rates to replace the lost contribution towards relief of rates as the total revenue received by the town from the population would be the same.

Reference had been made to the payment of all surpluses into a Betterment Fund and he again referred to the Electricity Act in this connection. Frankly, he did not like the term "betterment" as such a term imposed serious limitations on the applications of the fund monies so set aside. The Electricity Act refers to a "Reserve" Fund. This fund may be relied upon to meet any exceptional cases of capital expenditure, including items other than "betterment." Replacement of plant destroyed due to accident, which could hardly be regarded as betterment, could be financed from such a Reserve Fund, and it would be difficult to justify financing such an expenditure from a betterment fund. On the other hand, any act of betterment might be easily financed from a Reserve Fund. However, it was necessary in his view that the maximum amount which could be collected in such a fund should be limited.

The Act made provision for limiting the total amount collected in the Reserve Fund to 15%. Incidentally, this percentage is the same as that mentioned in the Resolution before the Convention. In the case of the Electricity Act, a limit was also set upon the amount that could be set aside anually to this fund, the limit being 3% per annum. Such a percentage might not necessarily meet the requirements of a Municipal electricity undertaking, although it would probably be as well to set some limit on the maximum annual contribution to this fund, any balance of surplus going to the suggested Profit and Loss account. If two such accounts were created, then it should be possible for the Municipality to make use of its Profit and Loss account as a Rates Equilization Fund to enable the Municipality to adjust its charges for electricity, making use of reasonable numbers of units and/or prices and generally levelling out periods of loss by periods of profit.

In regard to the period of Municipal loans by electricity undertakings, it was attempted to fix the period of the loan on a general assumption that the life of the assets purchased by an elec-

tricity undertaking averaged from 20 to 25 years. The difficulty of assessing the life of assets in relation to the periods of loans would be realised by anyone examining the accounts of several of the Reef towns, where in most cases the Municipalities possessed large electricity assets with very little capital expenditure outstanding this position having arisen chiefly from the very long life of the assets, namely, reticulation network. This state of affairs might easily place a Municipality in a very difficult position as regards its tariffs, having in mind possibilities of infrequent expenditure of large sums of money on the general improvement and/or reconstruction of its distribution network unless some means were provided of carrying relatively large amounts of surplus over a number of years to meet possible deficits over a similar period.

Without such a Rates Equalising Fund of some sort, a Municipality, to avoid making appreciable profits or losses, would naturally at times have to reduce its tariffs to ridiculously low figures and later increase them to somewhat abnormal figures.

An increase in electricity tariffs would necessarily have a detrimental effect upon the development of an electricity undertaking, as a general feeling of uncertainty is created amongst consumers contemplating installing current consuming devices. Whilst later reductions might be promised, the consumers would naturally be inclined to have no faith in the Municipality, and there would be an ever-present fear of further increases in the cost of electricity.

One other aspect which deserved very serious consideration was the general cost of electricity. The Commission's experience was that many an unprofitable undertaking could be made profitable if the charges for electricity were reduced. That a reduction in charges could have the effect of converting an undertaking operating at a loss to a profitable undertaking, seemed to be beyond the comprehension of many people.

As a result, there were a number of undertakings which were not doing what they might in regard to electricity development simply because they were attempting to derive profits by maintaining high rates or even increasing existing prohibitive rates. (Applause).

Mr. Councillor Fereday (His Worship the Mayor of Salisbury) said if the Convention had some advice to offer to the Municipal Councils in this country they should incorporate it in a clearly worded resolution—it should be definite. Some councillors might be difficult to deal with, but generally when they saw a resolution from the Association they had sufficient common sense to known that it was well informed. He supported the suggestion that the Convention should pass a resolution, and agreed that they would gain strength by submitting it to the conference of Municipal Treasurers. He hoped that a decision would be arrived at on those lines.

The President : This is a matter which will be considered by your Council, and it will be brought before the Convention again with a view to the passing of a resolution.

The Convention then adjourned for lunch.

On resuming,

Mr. Councillor Lugsdin (Pietermaritzburg) said he wanted to discuss the matter before the Convention from an entirely different angle.

He understood that no definite resolution had yet been passed.

Now the progress of a town or city depended to a large extent upon the attraction it had to offer in the way of reasonable rates.

All electricians were logicians, and the point he wished to make was a logical one that could not be disputed.

Take the case of Glasgow where the very high rates had brought about disaster; shipbuilding firms had gone south where rating was lower. Now the rates, being the financial backing of all municipal services, it is logical to take the profit of one service to make up a loss on another, perhaps, more essential service.

While electricity was becoming more and more an essential service, such services as pure water supply, sewerage service, good roads and health services are more essential. To put it in a nutshell, what was lost on the swings would be made good by the roundabouts. So that looking at the matter he thought this Convention would be well advised to leave it to each council to adopt its own policy. In other words make it purely a domestic matter.

Make your tariff for electricity reasonably low, shorten, if you wish, the estimated life of electricity cables, plant, machinery etc., so that your loan redemption charges will be higher; by so doing you will create a safety margin.

For Councillors or Officers to say it is all right, I shall not be here in fifty years time (that is when the time arrives to pay) was simply not only dishonest, but courting disaster. (Applause).

The President : This matter will come before us again after the Council has considered the suggestions that have been made up to now. I now have pleasure in calling upon Mr. Stevens to read his paper.

The Alice Municipal Electricity Supply Undertaking.

By F. STEVENS, A.M.I.E.E.
Municipal Electrical Engineer, ALICE, C.P.

Some Features of Alice, Lovedale and Fort Hare.

THE town of Alice has a population of 702 Europeans with about three times this number of natives. There are no industries in the town but a number of merchants who supply the needs of the townspeople and the institutions. One or two have large electric refrigerators to handle their stocks of perishable goods. The two hotels also have similar electric refrigerators. There are 131 consumers in the town excluling the institutions.

The municipal area includes the large native school and training institution known as Lovedale, which, although within the municipality and paying rates, is a circumscribed community with a governing body. During the school term there are something like 800 scholars in residence.

Electricity is used throughout except for cooking and water heating, in the science laboratories and domestic science classes a certain amount of current is used for heating purposes. In the trades section, there are the printing works, or as they are better known, "The Lovedale Press" which prints and publishes works from all parts of Africa. The whole of the plant is electrified, there being 7 motors and a number of lead and glue pots, their maximum demand being 16 K.W. In the carpentry shops the woodworking machines are also electrically driven, their maximum de-

mand being 15 K.W. The building department has a stone crusher electrically driven by a 14 horse power motor. Lovedale's water supply is also dependent upon a 10 horse power motor.

Within Lovedale there is a large native hospital which uses electricity for lighting, heating and surgical purposes. Their electrical appliances include a dressing steriliser, 2 K.W. loading, and two instrument sterilizers, each of 1 K.W. loading, then there is in addition a large refrigerator operated by a 1 horse power motor and two electrically driven pumps.

Lovedale has a total of 54 connections, 22 of which are private consumers.

Immediately abutting on the Eastern boundary of the municipal area, but not included in the municipality, is the South African Native College of Fort Hare, comprising educational buildings, hostels and staff residences, numbering 21 in all, each of which uses current for lighting and domestic purposes. The only other demands being for one electric pump of 2 horse power.

The width and breadth of the area supplied is 1¾ miles by 2 miles, with the railway between Kingswilliamstown and Cookhouse Junction passing through the Southern boundary of the town.

The foregoing will serve to illustrate the size and kind of town and to give some idea of the type of electricity supply undertaking necessary.

HISTORICAL.

The Municipal Electricity Undertaking was founded in 1921, prior to this the Lovedale Institution had its own plant operating on a 2 wire D.C. system. On the completion of the municipal scheme, the Institution abandoned its plant and drew its supply from the town.

The scheme as originally laid out had two suction gas engines driving, by means of belts, direct current generators of 40 K.W. rating and designed for 220/440 volts 3 wire working, each generator being provided with static balancers.

These machines were used for charging two banks of accumulators, each being of 230 volts, 290 ampere hour capacity, to enable a 24 hour supply to be given.

The original plant did not prove to be too great a sucess for a number of reasons, the suction gas engines appeared to be unreliable in their operation partly due to the machines themselves and partly due to varying fuel. In 1924 a new battery was installed after only three years service from the first and in a further three years the plates of the second battery had to be changed.

In the interim, a secondhand 56 K.W. vertical Diesel set was purchased. After the erection of this unit, the suction gas engines were sold, the generators being retained. Following this a second, also secondhand, unit identical to the first was acquired and erected as a stand by to the first.

The reason for secondhand plant being bought was that the original scheme estimated to cost about £7,000., eventually cost in the region of £16,000., due to the work being carried out departmentally and when prices were at their highest, then, due to the unsatisfactory service given and the necessarily high tariff, current was not used as fully as it might have been. In fact, at one time one did not dare mention electricity to the ratepayers for by then they were contributing at the rate of £1,000., per annum to the scheme. This position was, however, improved in the last three or four years, thanks to my predecessor, who put himself out to change the general feeling towards the Department, with the

result that since my assuming control of the undertaking, the scheme has steadily become more and more popular and there has been an ever increasing demand for current.

A third unit was installed in 1933, it being another secondhand machine of the same make as the former two and of 90 K.W. capacity. Following this, in May last year, a fourth set of 20 K.W. was introduced to do the work of the battery, which was then done away with as the service after midnight, when the plant was shut down, was so poor that the bus-bar voltage had often dropped to 160 by six in the morning, necessitating consumers using hand torches for dressing and shaving. The inefficiency of the battery at this stage can be gathered from curve No. 1.

GENERATION.

The present power station is located at approximately the centre of the area supplied and within half a mile of the railway station. This is not, however, the centre of gravity of the system, for the greater part of the day load is derived from the industrial sections and the hospital at Lovedale, which are both situated near the boundaries of the supply area as was mentioned earlier in the paper and which will be discussed later under the heading DISTRIBUTION.

The plant comprises three Mirrless Bickerton & Day, slow speed vertical oil engines, one 90 K.W. of three cylinders and two 56 K.W. of two cylinders, coupled direct with B.G.E. two wire D.C. generators, while the fourth unit is a 20 K.W. Ruston & Hornsby crude oil, single cylinder horizontal engine coupled with one of the original 40 K.W. G.E.C., three wire D.C. generators by means of a Renold's Inverted Tooth chain drive.

The reason for the 40 K.W. generator being driven by the 32 horse power engine is that such generators were already in the possession of the Council, as was explained earlier, and that the

maximum increase in plant permitted without obtaining the sanction of the administration was 20 K.W.

There is no need to describe the Mirrless or the Ruston engines at length, but I should like to mention a few features in connection with the fuel, lubrication and auxillaries of the power station, all of which affect the cost of production.

The cost of fuel per unit generated being the intrinsic value of the unit sold is inadvertently high, for although the consumption per unit generated is only .9 lbs., in monetary value this is .707 pence. The charges on the last consignment of fuel being as follows :—

Fuel oil 4,855 gallons	....	£91	1 4
Railage on ,, ,,	....	80	10 9
TOTAL	....	£171	17 1

From this it will be seen what little hope there is of selling current cheap enough for its universal use.

Lubrication is effected by means of sight feed, adjustable lubricators, which require topping up periodically. The used oil finds its way to a common point, the engine sump, whence it is drawn off and put into an electric boiler to settle and is ultimately passed through a Stream Line Oil filter which has embodied in it an immersion heater to reduce the viscosity and to accelerate filtering. The boiler previously mentioned is only used to hasten settling when demand calls for this.

Lubricating costs are as low as we can possibly get them, being only .013 pints per unit generated. This may be said to be due to the systematic recovery and filtration of the oil and to there being a limited amount of oil kept in the engine room, a make up quantity only, is drawn from stock once a week.

The starting of these machines is done with compressed air, each machine has its own receivers, comprising one blast and two starting bottles which are charged by means of a two stage air compressor which is an integral part of the machine. All three sets of air receivers are interconnected in case of emergency and the pressure of the system is 800 lbs. per sq. inch. While the receiver of the small set may be charged from the main system it does not hold as a stand by to the large sets. The small engine directly charges its own bottle to a maximum pressure of 200 lbs. per sq. inch., thus making it independent of all other plant.

The water cooling system consists of two electrically driven circulating water pumps in conjunction with duplicated cooling ponds. The cooling system on the small plant, which is looked upon as the house set, is on the thermal syphon principle and is thus independent of the pumps.

The switch board comprises four generator panels, two for the two rotary balancers, four outgoing feeder panels, one for the street lighting and earth leakage and one metering and switch panel for the station. On this last mentioned panel is provided means of transferring the station load from the positive to the negative side thus assisting with the balancing.

In connection with the metering of units generated, an Aron Clock instrument was used at one time, which functioned when it pleased, in fact, the story goes, that it was once used as a door stop. Due to lack of funds, two 100 Amp. 220 volt 2 wire motor type K.W.H. meters are being used, with their potential coils in series across the main bus-bars and their current coils shunted one with the other and connected between the generator bus-bars and feeder bus-bars. Before doing this the instruments were especially tested to operate together by the Meter Testing Department of the Cape Town Municipality.

The small set has its own three wire K.W.H. meter. It is proposed to introduce a second set of meters connected as in the first arrangement to record the total of units generated and to act as a check.

The usual earth leakage centre point ammeter and lamps working in conjunction with a limiting resistance brought into circuit by means of a low capacity circuit breaker is accommodated on the street lighting panel.

When the main battery was done away with, seven of the best cells were retained for a 12 volt emergency lighting system and for meter testing purposes. The battery is connected in circuit with the station lights for charging. By means of a selective switch it can be switched over for either of the two purposes.

One other thing in connection with the generation is the handling of the fuel oil and the recording of the consumption. In the first instance a tank car of approximately 5,000 gallons is ordered at the time, this is emptied on arrival into three 2,000 gallon tanks by gravity. A flexible rubber hose connects the tank car with a 2 inch underground main, approximately 25 yards long, which leads down to the storage tanks. At the power station there are two service storage tanks of 600 gallon capacity, one of these is in a parapit 4 feet below street level in order to enable the oil to be transferred by gravity again, from the tank cart of 300 gallon capacity. While the cart is away filling up at the main storage tanks the shiftman or his native pumps the oil up to the second tank which is at such a level as to keep the pump and fuel meter under a positive head so that when oil is being drawn for the engine service tanks this prevents the fuel meter recording any great quantity of air which might be entrained with the oil.

The fuel consumption is arrived at by recording the meter readings before and after each run. Each time the engine service tanks are filled, during and after a run the make up is integrated on the fuel oil meter. One meter serves all four machines, as there is a valve between it and each machine. The advantage of this arrangement is that the one meter records the total consumption for the month and can be easily checked against the monthly stock figures.

DISTRIBUTION SYSTEM.

On referring to the diagram of the distribution network it will be seen that the town is fed by two 3 wire, 220/440 volt overhead mains with 7/14 outers and a single No. 6 neutral. The Newton main serves the residential part, which is the southern section, while the Golloway main divides up into two secondary 3 wire mains, one feeding the centre of the town and the other the western section.

Lovedale, Fort Hare and the eastern side of the town are supplied from a ring main approximately three miles in length. The first section from the power station to Lovedale, 1,200 yards has .3 (19/.144) outers, the next 1,000 yards to the Victoria Hospital has .2 (7/6) outers.

The other leg of the ring from the power station to the boundary of Fort Hare, 1,600 yards has .2 (7/6) outers and a 7/14 neutral is used throughout. From here the main carries on with .1 outers to link up with the Victoria Hospital. The maximum load on the ring is only 75 Amps. per outer and yet the voltage drop is appreciable at times.

The distribution in Lovedale consists of two 3 wire mains following winding routes, picking up all and sundry. The one being 1,000 yards long and serving twenty five connections, including 10 horse power of motors, three electric stoves and one hot water geyser.

The town has only a 2 wire supply in most streets, with No. 8 conductors. In a number of instances these have to serve from ten to twenty connections and in one or two cases, stoves and refrigerators.

Initially Bates Lattice poles were used, although these have a good appearance they are not as convenient to handle or as serviceable as the tubular pole, a number having been damaged due to slight impact from vehicles. The cost of painting them is estimated to be about twice that of the tubular type, consequently they are never treated to a coat of colour.

The erection of house services is not straight forward with this type of pole, especially where they are drawn off at an angle. Shell insulators were used in the past, which could be conveniently wired on to the pole or cross arm at any point to give the desired spacing between service wires. At present, triangular shaped spreaders are being used with the shackle insulators attached to the two corners while the third is bolted to the ends of the cross arm by means of the insulator pin. Flying fuses of large proportions, having wing nuts and a rating of 25 Amperes are being standardised. It has been found that with the smaller size, overheating and arcing has been caused through the fuse not being tightened up. This is understandable, when one has on a pair of rubber gloves to catch hold of a nearled head which is less than a quarter of an inch in diameter. An approved type of line tap has been adopted in place of soldering. No. 10 S.W.G., H.D., copper wire is used for all services the consumers end being insulated with A.M.E.

STREET LIGHTING.

Street lighting is certainly a problem, on account of the trees, for which the town is noted. Suspended lights would, of course, solve the difficulty, but this form of lighting is costly as two poles are necessary for each fitting. Furthermore the maintenance costs are higher as a tower wagon

with two boys to push it would be necessary for changing lamps. At present, short arm brackets are used and lamps can be easily changed by means of a light extension ladder carried by one boy. The only light to be seen form the roads with this arrangement, is that at the base of the pole, which is very unsatisfactory and also inefficient, as higher wattage lamps, up to two or three hundred are often used with the hope of getting better results.

Inexpensive forms of long brackets are being designed which will be made up and tried out with the hope of improving this part of the undertaking. To give one some idea as to what the lighting is, the following are the size lamps used, 60, 75, 100, 150, 200 and 300 the total number being 119.

The market square, having an area of —?— sq. feet, and which is ultimately to be set out as a town garden, is lit up by means of three Duo-flux semi-floodlights, a product of BENJAMINS LTD., LONDON. These are erected at the top of 30 feet tubular poles with 1,000 watt clear gas lamps.

METER MAINTENANCE AND ERECTION.

With some of the smaller schemes this all important part is given very little consideration but on the Alice undertaking attention is being paid to this.

A section of the old battery room has been set aside for meter testing, a suitable switch board for testing purposes is in the making, while meter racks have been erected to accommodate spares. As the finances of the Department will not permit an expensive range of instruments to be got, one of each type of Ampere hour or Kilowatt hour meters in use has ben specially overhauled and tested so as to act as a sub-standard.

Once at least every twelve months, the meter readers are instructed to check all meters in service for starting current, that is by switching

on the nearest low power lamp. Those which fail to start on a reasonably low load are replaced by tested meters before next monthly reading.

The position chosen for the erection of meter boards is on verandahs near the kitchen or in the kitchen. The idea of this is twofold, firstly it facilitates meter reading and secondly it cheapens the cost of stove installations.

WORKING OF THE UNDERTAKING.

The departmental staff consists of the Municipal Electrical Engineer, an assistant with a native, two shiftmen, two apprentices and three shift natives. The engineer's duties are divided between all works of the department. The assistant concentrates more or less on house wiring and servicing consumers. He also takes relief shifts if called upon and deputises for the M.E.E. when absent. The two shiftmen and one of the apprentices each take a shift. The second apprentice who is capable of running a shift if necessary assists with the consumers servicing, mains, street lighting and meter reading.

The duties of those on shift consist primarily, of running the plant, attending to the switchboard and taking hourly readings. They are responsible for the routine maintenance of valves, minor adjustments and repairs, also attention to the oil filter, in order to maintain a supply of libricants.

Wages are paid once a week on an hourly basis, all overtime beyond the first hour is paid for, no stoppages being made in case of illness. A time sheet covering seven days is handed in for the purpose of making out the pay sheet and the allocating of wages.

CONSUMERS SERVICE AND TRADING SECTION.

Since the inception of the scheme all installation and repair work has been done by the department, a competent electrician having been employed for this purpose and to act as the engineer's assistant as previously mentioned.

Three years ago a show window was built into one outer wall of the power station facing the street, for the display of electrical appliances. Last year, when the battery was done away with, more accommodation was available and a show room was introduced, where stoves, refrigerators and small appliances were displayed, this has served good purpose.

An advertisement appears in the local newspaper each week extending an invitation to the public to call at the show room to learn of the advantages of using electricity.

I might state that it is no easy matter talking consumers into cooking electrically in the smaller towns where the tariff is necessarily high. There is, however, one argument to be used, which is although electric cooking is not cheap it is no more expensive than wood and coal, which sells at twenty to twenty-eight shilling a ton for brush wood and coal from four to four and six per 100-lb. bag with a possible chance of not being able to get either.

An assisted payment scheme is being introduced to foster the use of stoves, refrigerators and small appliances. This is to be in conjunction with the new tariff, which will be referred to later.

The following figures for the year ending December, 1934, might serve to illustrate the purpose served and the activities of this section of the undertaking :

SERVICES RENDERED and charged for including 7 complete installations	673.	
REVENUE from services and sales	£692	17 1
EXPENDITURE : Management, wages, material	£638	17 7

On a scheme such as that of Alice where the minimum of staff is engaged for generation and distribution purposes and where the amount of maintenance work is high, a time is reached when

servicing of consumers takes up more than its share of the staffs' time and tends to bring about negligence in connection with the production and distribution of current.

When this time is reached there should be sufficient work with sales to warrant a reliable contractor setting up business in the town. Some members might be of the opinion that it would be better to engage another man to cope with the demands of the department, but this would not necessarily meet the case, for in as much as a private individual would need assistance so the engineer would still have to do the interviewing of prospective consumers, the preparing of specifications and quotations and also the smaller services such as the replacing of fuses, etc.

DEVELOPMENT OF SCHEME.

Owing to past records being kept in a very rough form and in some instances, not at all, it has not been possible to trace the progress of the scheme back to its inception. This is a case in point of the necessity and value of keeping permanent records.

As I do not propose to wade labouriously through what details I have, I am including tables and curves showing clearly that, like most other electricity supply undertakings, this one has gone ahead right from the start from the point of view of units sold, loads and load factor but not financially, which will be understood from the schedule of annual working costs, which shows the high capital charges.

The scheme has been fortunate in possessing the small industrial load previously referred to, for without this the load factor would have been exceedingly low as may be seen by reference to the daily load curve.

It is hoped that in the near future, the town will have a laid on water supply dependent on electric pumping. Should this come about the units sold will be increased by 75% and the load factor be

greatly improved, for it has been suggested that two sizes of pumps be installed which will be remotely controlled from the power station and will operate singly or together on off peak periods.

The present figures for the larger appliances connected are 8 ranges, 23 refrigerators, and 4 water heaters. Current for cooking and heating purposes was supplied for the first time at 2d. and 1½d. per unit in January, 1934. The very marked increase in demand attributed to this may be gathered from the following table and the curve showing the units generated and sold.

Analysis of Sales.

This table will serve to show the increased sales and revenue for the 2nd quarter of 1935 as against that of 1934.

	1934.	1935.	Increase %	Decrease %
Domestic	13,050	16,899	29.25	—
Commercial	9,445	14,124	49.50	—
Industrial	4,761	6,727	41.30	—
Educational	5,231	6,643	26.90	—
TOTAL	32,487	44,393	37.30	—
Revenue	£855 13 10	£1,015 1 5	18.60	—
Average price per unit	6.38d.	5.50d.	—	13.80

In order to further encourage the demand it is now proposed to charge a flat rate of 1½d. nett for all units consumed over and above those covered by the minimum charge and ¾d. nett for water heating at restricted hours. Hot water at 1d., non restricted is not being encouraged.

I should like to point out that a greater reduction could possibly be offered but the response would probably call for more capital expenditure in the way of plant as the present installed capacity is only 230 K.W. with a maximum normal output of only 110 K.W., and from the annual

load curve it will be seen that we are already verging on this figure having attained a peak load of 97.8 K.W. this winter.

This procedure however, will have to be seriously considered in the near future with an eye to changing over to alternating current, otherwise the development of the undertaking will be greatly hampered.

Before this comes about I hope that the feasibility of using steam turbines for small undertakings operated with a maximum output of say, 250 K.W. will be debated at one of our Conventions. In this connection it had been my intention to present at this Convention a paper entitled "The Feasibility of Using Steam Turbines for Small Undertakings," but, realising the differences of opinion that no doubt exist, I though it necessary to accumulate more facts and figures than I have in my possession at the moment.

CONCLUSION.

In conclusion I beg to tender my apologies for the incompleteness of this paper owing to the reason that firstly I was preparing another, as previouly mentioned and secondly to the lack of statistics to work from concerning the Alice undertaking.

The Alice Electricity Supply Undertaking.

REVENUE DURING FIRST HALF-YEAR 1935.

81,290 Units sold.

	Units.	Av. per Unit.	Revenue.
Private supplies	72,282	4.890d.	£1,473
Municipal	671	4.651d.	13
Street Lighting	8,337	6.510d.	226
Other sources	—	.980d.	331
TOTAL	81,290	6.010d.	£2,043

The Alice Electricity Supply Undertaking.

EXPENDITURE DURING FIRST HALF-YEAR 1935.

81,290 Units sold.

	Expenditure.	Total	Pence per Unit sold.	Total.
GENERATION :				
Fuel	£184		.542d.	
Railage	145		.428d.	
Oil, waste and stores	34		.101d.	
Salaries and wages	270		.798d.	
Building and works	3		.213d.	
Plant and machinery	69		—	
		£705		2.082d.
DISTRIBUTION :				
Salaries and wages	£25		.074d.	
Transport	7		.020d.	
Mains	15		.044d.	
House services	12		.035d.	
Street lamps	11		.033d.	
		£70		.206d.
MANAGEMENT :				
Salaries and wages	£177		.521d.	
General charges	57		.168d.	
Audit	15		.044d.	
		£249		.733d.
CAPITAL EXPENSES :				
Interest on loans	£322		.950d.	
Interest on overdraft	19		.056d.	
Loan repayments	436		1.289d.	
Contribution to capital	169		.500d.	
		£496		2.795d.
TOTAL		£1,970		5.816d.

MUNICIPALITY OF ALICE.

ELECTRICITY SUPPLY DEPARTMENT.

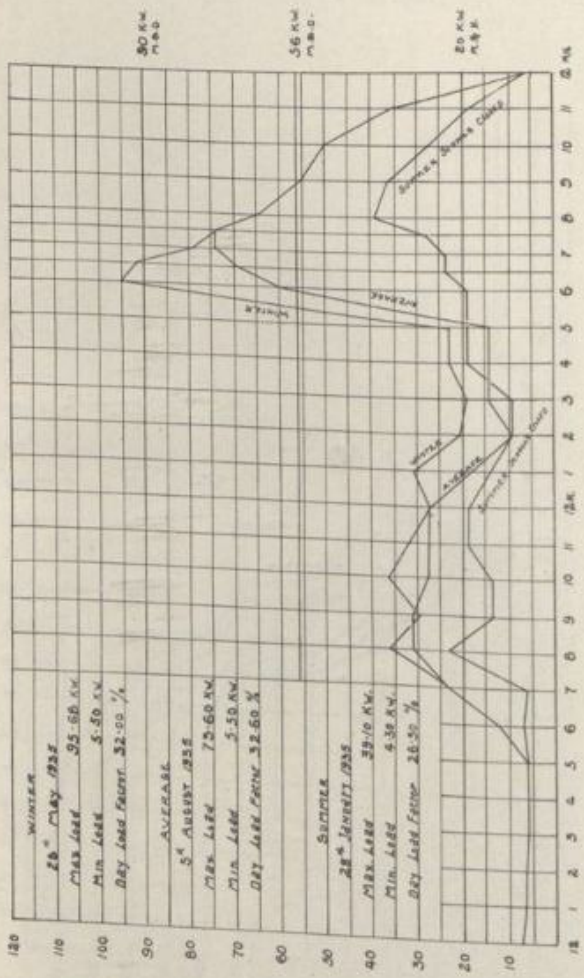
SCALE OF CHARGES FOR ELECTRICITY.

Framed under Ordinance No. 6 of 1911. Regulation No. 32, 34, 37 promulgated under Provincial Administration Notice No. 82 of the 5th March, 1931, are hereby repealed and the following substituted therefore :

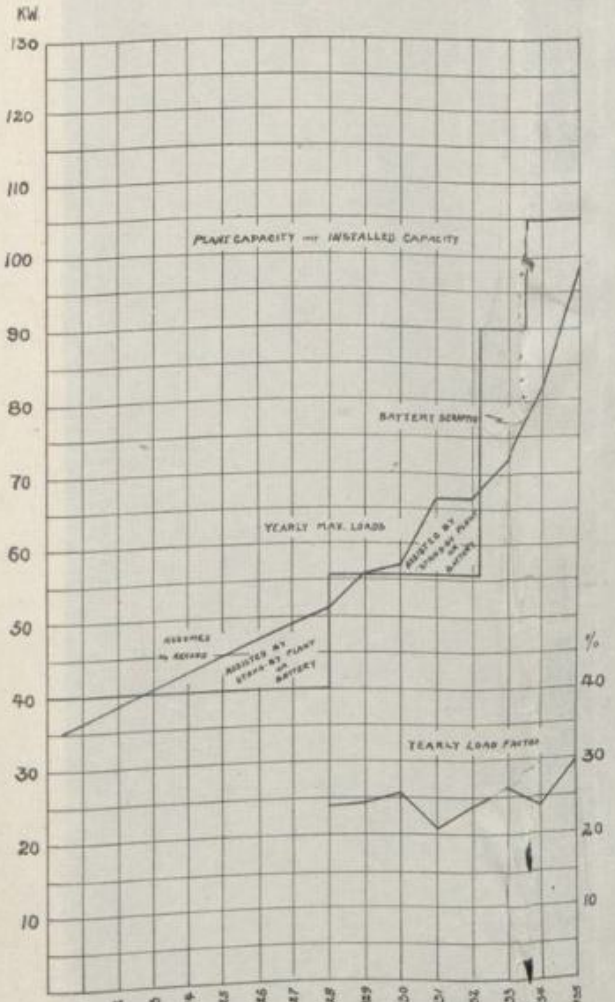
32. The following tariff of charges will be in operation as from the first day of the month following the promulgation of this notice.

	Per Unit NETT.
SCALE "A." Lighting in private houses. All units at 1/3d. Minimum charge. 5 units.	
SCALE "B." Combined rate for Lighting, Cooking, Heating and all Domestic purposes in Private houses	
This is an alternative tariff and consumers desiring to fall thereunder must bind themselves thereto for at least 12 months.	
Minimum charge 8 units plus one unit for every hundred pounds or part thereof valuation of buildings not including land, at — — — — — —	1/-
(Such minimum charge shall not be less than 10/- or more than 18/-).	
Remainder — — — — — — — —	1½d.
SCALE "C." For Churches, Educational buildings, Libraries, Unlicensed Clubs, Entertainment Halls, Cafes and Municipal Buildings :	
Minimum charge, 10 units @	1/-
Remainder @	6d.
SCALE "D." Hotels :	
Miniumu charge, 80 units @	1/-
Remainder @	3d.
SCALE "E." Offices, Shops, Stores and Government Buildings :	
Minimum charge, 6 units @	1/-
Remainder, @	9d.
SCALE "F." Hostels and Dormitaries :	
Minimum charge,	
Next, 50 units @	9d.
Remainder, 250 units @	2d.
@	1½d.
Nursing Homes :	
Minimum charge,	
Next, 100 units @	9d.
Remainder, 500 units @	2d.
@	1½d.
Victoria Hospital :	
Minimum charge,	
Next, 300 units @	9d.
Remainder, 1,000 units @	2d.
@	1½d.
SCALE "G." Applicable to consumers under Scales A.C. D.E., for Cooking, Heating and all purposes other than lighting, manufacturing or industrial uses.	

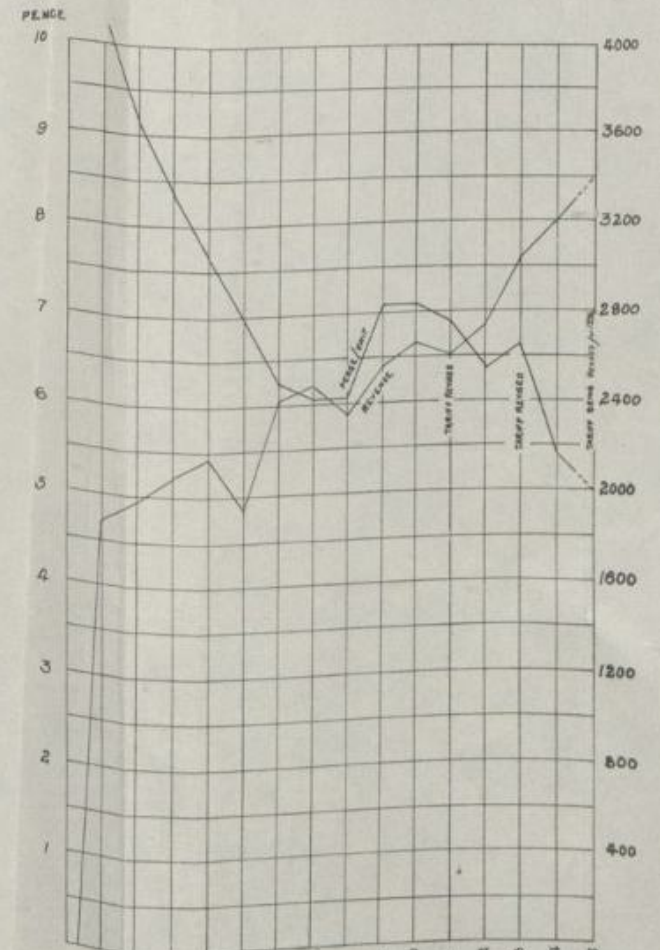
DAILY LOAD CURVES.



LOAD - LOAD FACTOR & PLANT CAPACITY.



PENCE PER UNIT SOLD - REVENUE.



(Not applicable to the supply of electricity for motors other than those driving automatic refrigerators and small machines having motors of less than 1 H.P. incorporated in such machines.)

Minimum charge,	6 units @	1/9
Remainder,	@	1½d.

SCALE "H." Water heating (24 hours) applicable to all consumers subject to the approval of the Municipal Electrical Engineer after paying due regard to the loading of the distribution mains and the generating plant, @ 1d.

Minimum charge 5/– for every 500 watts or part thereof covering 60 units.

Water heating (restricted hours) i.e., not between the hours of 5 p.m. and 9 p.m.) applicable to all consumers subject to the approval of the Municipal Electrical Engineer as above and in addition see under, @ ¾d.

Minimum charge 5/– for every 500 watts or part thereof covering 80 units.

The wiring of the water heater in this case shall be so arranged that the current consumed by it shall be separately metered and connected through a two way switch controlling both the kitchen lights and plugs and the water heater, in such a way that when the kitchen light and plugs are on the heater is off and vice versa.

The Council reserves the right to instal a time switch whereby the water heater can be switched off automatically during peak loads, in which case the minimum charge will be 6/– for every 500 watts or part thereof covering the same number of primary units.

SCALE "I." Shop windows, Entrance Gates, Bridges, Signs and Registered Electrical Contractors Business Premises, subject to consumers agreeing to maintain the whole of such lighting from dusk until 10 p.m. on six nights per week :

Minimum charge,	6 units @	5d.
Remainder,	@	5d.

SCALE "J." Power.
Minimum charge 2/6 per Horse Power or Kilowatt provided that in no case shall the minimum charge be less than 5/–.

First,	500 units @	3d.
Remainder,	@	2d.

SPECIAL AGREEMENTS :
Notwithstanding the foregoing charges the Council shall have the right to enter into special agreement with large consumers for the supply of electric current and any agreement so formed shall be subject to the approval of the Administrator.

The President said they were very grateful to Mr. Stevens for his paper, which would be of particular interest to Engineers in charge of small undertakings, and a brief discussion followed.

VISIT.

A visit was then paid to the Wireless Transmitter Station of the African Broadcasting Co., situated at World's View.

CIVIC FUNCTION.

In the evening a Civic Reception and Dance was given by the Mayor and Council in the City Hall which was very largely attended.

TUESDAY, September 24th, 1935.

The Convention resumed at 10 a.m. with the President in the Chair.

LICENSING OF ELECTRICIANS.

Mr. Horrell (Pretoria) in introducing the subject presented the following report :—

The City Council of Pretoria recently endeavoured to introduce By-laws for the licensing of electricians but on submitting these to the Provincial Authorities they were declared to be ultra-vires in so far as they prescribed qualifications. The Town Council of Springs has, I understand, met with the same experience. The Provincial Authorities have obtained legal opinion and their advisers assert that Provincial Councils have not the power under the South African Act to prescribe qualifications for persons who desire to carry on any trade or business and cannot, therefore, delegate such powers to Town Councils. The

Town Councils' powers in regard to licensing are held to be confined to registering all persons engaged in the particular trade or business and providing penalties for unlicensed persons carrying on such a trade or business. The matter is serious for those towns who desire to license electricians working in their area of supply, but even more so in the case of those towns who at present have By-laws for the licensing of electricians, since if the legal opinion is accepted there is every possibility that their By-laws, if contested, would be declared ultra vires.

The only means of legalising the matter lies in obtaining parliamentary legislation to empower the Provincial Councils to delegate to Town Councils the power of prescribing qualifications for the licensed trades such as those of electricians and plumbers. Our Association is hardly in a position to institute such proceedings, but, fortunately, the Municipal Association of the Transvaal has the matter in hand, and, I understand, will forward a request to the parent body from the Congress to be held next month, asking them to enact the necessary legislation. I feel that a similar request from this Association would strengthen matters, and therefore propose :—

> "That in so far as the prescribing of qualifications for the licensing of electricians and plumbers renders the By-laws for such licensing ultra vires, this Convention of the Association of Municipal Electrical Engineers requests the Municipal Association of South Africa to proceed with the enacting of legislation to legalise the position."

Mr. Councillor Hassett (Springs) in seconding, said that being mindful of the fact that Town Councils are the custodians of the safety of the public, as well as of their property, the matter of security was certainly one which the Association should strive for. One means of assuring the public was to make certain that persons installing electric wiring and fittings were thoroughly competent to do such work, and that local authorities should exercise control thereof. It might be said that the Councils' officials are empowered to in-

spect the work of the electricians upon completion; but they wanted more than that. They wanted to be in the position to impose a penalty upon anyone who performed work in such a manner that it became a danger to the public. To that end the Springs Town Council had drafted by-laws, but on their being submitted to the Provincial Administration they were very much surprised to be informed that these proposed by-laws were ultra-vires the Council. Nevertheless, similar by-laws are at present in operation in other towns along the Reef, and he solicited the support of the Association of Municipal Electrical Undertakings in the endeavours of the several Town Councils who are striving to secure such powers for all local authorities. It was necessary that the Provincial Councils should have the authority before they could delegate it to the Town Councils, and he strongly supported the resolution to that effect. Springs would be very grateful if this could be achieved.

Mr. Councillor Phillips (Salisbury) fully agreed with Mr. Hassett. Control was necessary not only in regard to installations, but also repairing work, which could now be done by any Tom, Dick or Harry.

Mr. Clinton (Salisbury) said he had always felt that the licensing of electricians was a national matter which should be taken up by the Mines and Works Department rather than by public bodies. The difficulties obtaining ruled out its being done by local authorities. It should be done by the Government in the interest of the public. He thought it was generally accepted that they as a body owed a duty to consumers. One did not usually stress the dangers, but in this matter there were difinite dangers, and for that reason he suggested that they approach the Government. (Hear, hear). If they could license engineers and boiler attendants, why should they not also license electricians?

Mr. Harvey (Springs) said he would like to explain what happened at Springs. They sent a draft of the proposed by-laws to the Administrator, who replied that they could not prescribe examinations. The latter were then eliminated, and the by-laws were again sent to the Administrator, who again sent them back for a further amendment. He said the Council could only license for the purpose of registration. Plumbers and drain layers could be licensed by examination but that could not be done in the case of Electricians. That was done through the Department. If they could license plumbers and drain layers, why should they not also license Electricians?

Mr. Councillor Hassett (Springs) seconded the motion moved by Mr. Horrell.

There was no seconder for Mr. Clinton's proposal, which fell away.

Mr. Eastman (Cape Town) thought he was right in saying that the new regulation would include a clause prescribing that Electricians must be licensed.

Mr. Milton (Elec. Supply Com.) stated that licensed Electricians were referred to in the proposed new regulations. In the circumstances if the regulations were made to apply throughout the four Provinces and ultimately became Union Law, it followed that it would be necessary for Electricians to become licensed before they could operate within Municipal areas. As regards the qualifications which would be required before a license could be issued, this matter would have to form the subject of a separate bill and had not, so far as he was aware, been discussed in full detail by any committee as yet.

The President : From what has just been stated it would appear that the matter is being dealt with. That being so, would any useful purpose be served by putting the motion?

Mr. Horrell (Pretoria). In view of what has been said, I withdraw my motion.

Mr. Milton (Elec. Supply Com.) thought it would be as well to allow the resolution to stand, as it might be some considerable time before the new regulations were adopted in the several Provinces and/or become a Union Law. If this question was voted on by the Association, the Association's resolution might easily strengthen the arguments in favour of the universal application of the regulations, which would be all to the good of the cause.

Mr. Harvey (Springs) hoped the matter would be pressed forward with all speed.

The President : Perhaps in the circumstances Mr. Horrell will allow his resolution to stand?

Mr. Horrell : I agree.

The resolution was then agreed to unanimously.

Mr. Horrell (Pretoria) then read the following notes he had prepared on the subject of 'Earthing'

Earthing

The subject of earthing has been engaging a great deal of attention both here and overseas and the general feeling appears to be that, while certain minimum requirements should be prescribed, we should be careful to avoid a wholesale introduction of regulations which might have the effect of hampering the progress of the electric supply industry.

Since our last convention, we in Pretoria, have investigated several peculiar cases of people receiving electric shocks and it is with a view, therefore, to inducing discussion which will point the way towards the steps which should be taken, that I am bringing the matter to the attention of members.

While none of the shocks referred to have been attended by fatal consequences, I need hardly emphasise that if the confidence of the public is not to be shaken in regard to the safety of domestic electrification, it is highly desirable that even the slightest shocks should be avoided if possible.

As regards the particular form of electric shock which has been engaging our attention, the following is a typical example.

Several members of a household repeatedly received fairly severe shocks on touching the cold water tap while in the bath. Investigation showed that an insulator had broken down on the pole opposite the house and that the water supply pipe to the premises passed within 16 feet of the pole. The pipe passed through moist shaley soil while the pole was embedded in solid rock. The poles, crossarms, etc., of the overhead line were bonded to an earth wire which was connected at regular intervals to buried earth plates in the usual manner.

The bath itself stood in a galvanised tray on a wooden floor and both hot and cold water taps were mounted directly on the bath. It is evident, however, that no effective metallic contact existed through the bath between the water and waste pipes, since persons in the bath received shocks whenever they touched the cold water tap. As soon as the faulty insulator had been replaced the trouble disappeared.

Although the premises in which such shocks have been obtained have all been connected to the electric mains it is quite evident that similar

occurrences could have taken place in unwired premises and any precautionary measures taken should therefore be made applicable to all premises in the area of supply.

The matter is brought to mind of a man being electrocuted in one of the coastal towns some years ago under somewhat similar circumstances and if my memory serves me correctly, the premises were not connected to the electricity mains.

A simple precautionary measure suggests itself, viz : that of bonding all hot and cold water piping to the waste pipe.

It may be that the Safety First Committee, who have been considering the draft wiring regulation and who have, I understand, devoted considerable time to the question of earthing, may have already considered this matter and made this simple provision, but as such wiring regulations are applicable only to wired premises I feel that the matter should be pursued further and be incorporated in the Building By-laws, so that consumers and non-consumers may receive the same protection.

As many of you are probably aware, the majority of house service connections in Pretoria are taken overhead to shackles on the roof. During the rainy season complaints of receiving shocks from the gutter downpipes are fairly prevalent. This could of course be overcome by bonding the downpipes to the waste pipes as before.

Regulations incorporating the above proposals should not incur any hardship and it is hoped therefore that if other members are in agreement, the proposals should be submitted to the Safety First Committee, the S.A. Institute of Electrical Engineers and the Municipal Association of South Africa for their information and action.

I have received a letter from Mr. J. G. Davidson, the newly appointed Electrical Engineer to the Port Alfred Municipality, in which he expresses concern in regard to the methods of earthing adopted there.

Port Alfred had no laid-on water supply and no serious attempt appears to have been made to try and obtain effective earthing at consumers premises. He finds that in most cases a piece of ordinary conduit stuck in the ground is all that is provided.

The majority of the houses are of the wood and iron variety and as the conduit is in many cases secured directly to the iron, Mr. Davidson has been called upon to investigate numerous reports of houses being "alive."

The problem of earthing concerns us all for even those of us who are fortunate enough to have a water supply system available have to face the fact that in South Africa sufficiently low values of earth connection resistance are difficult to attain. The problem, therefore, assumes greater proportions where rural and urban areas without a laid-on water supply are concerned.

The rapid progress that is being made in the sphere of domestic electrification has brought this problem to the fore since with the methods of earthing generally applied, low resistance and high current carrying capacity are essential to the system as a means of protection.

The difficulty of achieving and maintaining these conditions lies in the extreme variability of the earth resistance value consequent on weather conditions and the lack of a simple and ready means either of measuring this resistance or of ensuring continuity of the earth connections on which we rely for safety. The installation of heavy duty appliances, such as electric stoves, calls for careful attention to the matter of

earthing, since the isolation of the faulty appliance before it acquires a dangerous leakage potential is rendered uncertain by the fact that the circuit fuses on which reliance is placed for isolation, may require such a large current to blow them, that unless the earth connection is of a very low order, it may prevent the flow of the necessary fusing current. The stove might therefore remain alive until discovered with unpleasant or even fatal consequences.

The latest edition of the I.E.E. wiring regulations requires that the earth connection resistance shall not exceed 1 ohm. and that when this is unattainable, earthing shall be supplemented by an earth leakage trip adjusted to operate with a leakage current of not more than 30 milli-amperes.

In certain parts of the Continent earth leakage trips are employed to the exclusion of all other systems particularly in rural areas.

Unlike the more usual form of earthing, this system affords protection against leakage potentials without relying on the circuit fuses or other form of overhead device for isolation of the faulty circuit. Isolation is effected by means of circuit breakers which take the place of the normal main or subcircuit switches in the circuit to be protected, the leakage currents operating a trip. Instead of the earth wire from the appliance or appliances being taken direct to earth it is diverted through the trip coil. No radical departures are therefore necessary in regard to the wiring of the installation.

The Continental type are so designed that even with hundreds of ohms resistance in the earth circuit isolation is effected without the leakage potential exceeding about 40 volts.

I have had the opportunity of witnessing a demonstration of the system and thinking that other members might care to see it in operation, I have asked representatives of the A.E.G. En-

gineering Company to bring their model here and demonstrate it. You will therefore be able to judge the system for yourselves.

I understand that the circuit breaker employed is little more expensive than the standard I.C. switch and although it would naturally be impossible to substitute it in all existing premises it appears to me that we might consider its application to all new installations.

It would certainly dispense with our problem of low earth resistance values in conjunction with domestic supplies and remove the present obligations to the wholesale use of 3 pin plugs.

Mr. Heydorn (A.E.G.) said many members might like to see the appliance referred to by Mr. Horrell. He did not think they could use it generally, but it was a very good start. It was more suited to the upcountry than the coastal towns. To a certain extent they were up against it. The other day he heard a member say that he knew of many houses in which the water pipes were electrified. In Pretoria they had their overhead mains and on top of that was the earth wire, but honestly he did not think it worth the money. Only quite recently they had had trouble, when a little child in a garden received a shock from a water pipe. She was standing on damp ground and happened to touch the top of a water pipe. They carried out an examination and found that the earth plate was within three feet of the water pipe. This was the kind of thing they wanted to prevent and if they could bring in a regulation to prevent it they would be doing something worth while. (Applause).

Mr. Ralston (Dunee) congratulated the author on his paper. The question of earthing was more important especially with the development of more extensive use of electrical apparatus pertaining to house usage. He read in the "Star" recently that the majority of houses in a certain town were not earthed. The smaller towns who were contem-

plating change-over were placed in a very awkward position particularly where the installation was of a very old type and the work had been carried out in a very slip-shod manner. Were they to go to a house and say they were condemning the wiring because it was not in accordance with the regulations? His experience was that most of the old house wirings were far better on test than some of the new wired houses which were carried out completely in tubing. Unless earth plates were put down in a proper way, they were very little use in a dry climate. It was quite easy to earth on to a water pipe. The type of apparatus used for domestic purposes was not constructed so as to provide an earth connection. Take the kettle, perhaps the most dangerous apparatus as far as shocks are concerned. It could be used in a house if there was earth connection on this implement. The manner of the flex connecting an electric iron was also unsatisfactory. They often became frayed and the frayed end would come in contact with the spring attached to the connector. The question of having suitable earth points on all domestic apparatus will in the future have to be seriously considered.

Mr. Metelerkamp (Bulawayo) was of the opinion that earth leakage protection is not the final solution to the problem, nor will it eliminate every possible accident.

Mr. Horrell has referred to earth leakage relays installed at the meter position. These would then give no protection to accidents on roofs of houses where overhead services were employed. At the Port Elizabeth Convention the Chief Inspector of Machinery, Mr. Clutterbuck, supplied statistics which showed that, of the 16 fatal accidents in 1931, six of these were due to "contact with uninsulated wires and apparatus on roofs." To eliminate this possibility the earth leakage relay would have to be mounted on the pole from which the service was taken. The relay would then have to be of a waterproof type and the operating coil

sufficiently robust to withsgtand surges and pressure rises associated with atmospheric conditions with which we have to contend on low tension lines in this country.

With the present high speed of traffic by means of motor vehicles, fatal accidents cannot be entirely eliminated, and the same thing applies to any form of modern powered machinery. As long as toasters, irons and domestic apparatus are connected by means of a piece of flex accidents must occur. Out of 2,000 odd fatal accidents which occurred in homes in Great Britain, only 13 of these were due to electricity, whilst over ten times this number were due to people falling down stairs.

He was of the opinion that, provided modern practice is followed in connection with wiring, earthing service wires, etc., electrical power is safer than any other for use in homes.

The President pointed out that the question of "earthing" had already been dealt with under the regulations.

Mr. Horrell—(replying to discussion) said he merely wished to draw attention to the slight danger which may exist. The Safety First Committee have the matter under consideration and he felt therefore that if they realise that the Association is fully alive to the position, they will urge the adoption of the necessary measures. At a later stage he proposed to submit a resolution for transmission to the Safety First Committee. (Hear! Hear!).

Some Considerations in the Selection and Maintenance of Electricity Meters.

By A. M. ALBERTIJN, B.Sc., A.M.I.E.E.
Test Engineer CITY of CAPETOWN Electricity Department.

In the absence of the author Mr. Eastman (Cape Town) read the following :—

Integrating Electricity Meters for recording kilowatt-hours have in recent years received considerable attention not only in the research laboratory but also in the hands of the manufacturer, and the latter, egged on no doubt, by the keen competition on the market has added his quota in making the modern meter an article which gives excellent value for money. A distinction, however, must be drawn between the meter which superficially may appear to be a sound proposition but which only by continual coaxing can be held to the "path of virtue" and the high grade meter which faithfully continues to record the energy delivered to the metered circuit although neglected for lengthy periods during which it only receives a casual glance from the meter reader when taking the monthly reading. From this it should not be inferred that to settle the meter question a Supply Undertaking need only invest in good quality meters and then forget their existence from a maintenance point of view. A person buying a padlock of good quality would be considered very unwise if he continued to use it without satisfying himself that it was really locked when he turned the key. A similar reasoning applies to an electricity meter, and a system of

routine inspection and testing of electricity meters when on service is essential as neglect of this important factor may result, either in the Supply Authority losing considerable revenue or individual consumers paying for far more than what they have actually received. It may be argued that if a census of all meter errors were to be taken the over-registering meters would in all probability be counter-balanced by those which under-register and therefore the Supply Authority neither gains nor loses. A moment's reflection, however, will show that such reasoning is most unjust to the consumer who pays "in excess" and can only lead to loss of goodwill and widespread dissatisfaction.

Before dealing with the actual selection of a meter to "suit the job" it may be as well to consider briefly a few salient points in the construction of a meter.

In a motor meter, the type to which we shall confine our attention, there is essentially a rotating armature the revolutions of which are integrated through suitable gearing on a dial which is calibrated in kilowatt hours. Thus speed of armature $\times$ time = K.W. hours and as the latter may be written power $\times$ time it is obvious that for accurate metering the speed of the armature must at any instant be proportional to the power delivered to the metered circuit.

How closely to this ideal a meter will adhere during its useful life depends largely on the materials used in its construction and the attention which has been given in its design to combatting the various factors which tend to destroy its accuracy.

If we consider an electricity meter as an electric motor with a variable load then the various components which constitute the load can be classified as follows :—

(a) The eddy current brake, i.e., the retarding torque due to the rotation of the meter disc between the poles of the brake magnet.

(b) The friction of the upper and lower bearings.

(c) The air friction of the rotating parts.

(d) The friction of the dial train.

(e) Other retarding torques peculiar to the type of meter such as brush and fluid friction in D.C. meters and the self braking effect of the rotation of the disc of an A.C. meter in the flux produced by the shunt and series windings.

If these individual braking effects were constant in value during the life of a meter the compensation carried out during the initial testing and adjusting of the meter would suffice to ensure prolonged accuracy. Variations, however, are bound to occur and whereas in a high grade meter they are likely to be small, they may in an inferior quality meter, be of such a magnitude as to entirely destroy the accuracy of the meter.

Let us consider the above-mentioned braking effects somewhat more in detail.

(a) Is the principal retarding torque and in a normal meter, except at very low speeds of the armature, is considerably in excess of all others. As a matter of fact, this torque almost entirely counterbalances the driving torque and for a correctly adjusted meter we can assume that a steady speed of rotation of the meter armature will be maintained when the braking effect of the brake magnet(s) balances the driving torque.

For a disc of any given material the principal factors which establish the value of this braking torque are the speed of the disc, the distance of the brake magnet from the centre of the disc, and the effective flux from the brake magnet which cuts across the disc. Moreover as the braking torque for a given speed varies as the square of the flux it is obvious that any change in flux with the passage of time will seriously affect the accuracy of the meter.

Hence in a good quality meter we must look for brake magnets which can be effectively locked in position after adjustment, and whose retentivity is above suspicion.

In selecting a meter there is unhappily no ready test for determining whether the retentivity of the brake magnets is satisfactory and the purchaser must be guided by the performance of magnets manufactured by the same makers and used in meters which have had long periods of service.

It may be mentioned, however, that the manufacture of so called permanent magnets in reliable makes of meters has been brought to a fine art and trouble in this direction has been reduced to a minimum.

Regarding the locking of the magnets in position the writer favours the type of adjustment in which a magnetic shunt of the micrometer type is used. This after adjustment is locked in position by means of a set screw and as the brake magnets are permanently fixed in position the possibility of the adjustments being altered even though the meter be seriously jarred during transport, is very remote.

Moreover a micrometer type of adjustment considerably facilitates adjusting the meter and is greatly preferred to the method where the magnet is bodily moved through unmarked distances.

(b) THE FRICTION OF THE LOWER AND UPPER BEARINGS.

Considering the lower bearing first :— A great deal of paintstaking research work has been carried out by various investigators as to the cause and cure of trouble with jewels and pivots in meter bearings. From these investigations it appears that due to the very small area of contact between the pivot and the cup of the jewel a

pressure of a very high order at least 100 tons per square inch exists at the centre of the pivot falling away to zero at the edge. In rotating the friction between pivot and jewel causes the minutest particles of almost molecular dimensions to be torn off the pivot. These particles at once oxidise if exposed to the air and form a reddish deposit of rust in the cup. This no doubt acts as a scouring agent in hastening the destruction of the pivot and jewel. It would appear that lubricating the pivot would go a long way to cure the trouble. M. Rene-Marcel Fichter however in his paper "Contribution to the study of Electricity Meters" published in June, 1924, "Revue Generalé de l'electricite" expressed the opinion that not only is oil useless, but it is harmful in so far as when fresh it collects dust, and when dry it produces a kind of resinfication forming a solid film on the jewel.

In a paper by Mr. V. Stott published in the journal I.E.E. in 1931 it was shown however that lubrication did play an important part in the life of meter pivots and jewels and tests were made which shewed that although the presence of oil made no appreciable difference to the initial frictional torque yet the useful life of the pivot and jewel was in certain instances increased by lubrication from ½ to 15 million revolutions. Thus although the high pressure between pivot and jewel will actually exclude the oil in its lubricating capacity from the centre of the area of contact yet a certain portion of the area will be lubricated and its presence moreover greatly minimizes the forming of rust.

It is of the utmost importance, however, that the correct type of oil be used and only such oil as recommended by the makers should be employed.

The question of lubrication has only recently been brought into the limelight and although there are numerous types of meter jewels and pivots which are not specially adapted for oiling it is a significant fact that the manufacturers of a high grade American meter have now introduced a new type of lower bearing which runs in oil and is rendered oil and dust tight by special design.

Regarding the upper bearing, the higher the centre of gravity of the disc and spindle the more tendency there will be for increased friction at this point. A well balanced rotor, however, with a centre of gravity as low as possible (if possible below the point of support) will not suffer from any appreciable friction at the upper bearing which will merely function in the nature of a guide. In a two or three disc polyphase meter, however, a fairly high centre of gravity is a necessary evil and in such cases the application of a drop of jewel oil to the upper bearing will have beneficial results.

(c) AIR FRICTION.

This is relatively unimportant as it remains constant during the life of the meter and moreover in view of present-day tendencies to adopt low full load disc speeds the modern meter suffers little disadvantage from this factor.

(d) DIAL TRAIN FRICTION.

This is a fruitful source of inaccuracy in a meter and the following points should be closely watched :—

(1) Meshing between worm or pinion on armature spindle and first gear wheel on dial train. A fixed meshing position is essential and is a feature of the majority of present-day meters. This means that when the dial assembly is removed and re-

placed it will have only one position for engaging with the worm or pinion on the shaft and the possibility of having a mesh which is either too tight or which slips, is avoided.

(2) Cyclometer dials unless of the best workmanship are liable to introduce a great deal of friction especially when the figures are changing on more than one counter simultaneously, e.g., 99 to 100 and so on, and it is to be noted that only pointer dials are considered in the latest British Standard Specification for meters. This type of dial with well cut teeth accurately meshed and of robust construction gives excellent service.

(e) RETARDING TORQUES PECULIAR TO THE TYPE OF METER.

The retarding torques considered under (a), (b), (c) and (d) affect both A.C. and D.C. meters alike, under (e) however, we have to consider torques peculiar to each class.

D.C. meters, due to their operating principle have to contend with certain retarding torques which may assume quite alarming proportions during the life of the meter and it is for this reason that it is very difficult to maintain a similar degree of accuracy with D.C. as with A.C. meters. It is no doubt due to the growing popularity of A.C. distribution that very little progress has been made in improving the performance of D.C. meters and their well known defects appear to be more or less taken for granted. Space will not permit going into detail on this subject. To mention one factor however—the varying friction of the brushes in the commutator type of meter will seriously affect the low load accuracy of the meter unless regular attention is given to these parts so as to maintain the rubbing surfaces in a clean and polished condition.

Regarding the self-braking effect of the driving flux in an A.C. meter, this will be negligible if the angular speed of the disc is very low in comparison with the angular speed of the travelling magnetic field produced by the alternating series and shunt fluxes, i.e. the speed of the disc at full load must be within reasonable limits say within the order of 40 revolutions per minute.

The overload type of meter is no doubt one of the great advances in modern meter technique and the reduction of the effect of the self-braking torque in this type of meter has largely contributed to this achievement.

Whereas in the past the accuracy curve of a meter commenced to drop when its full load rating was slightly exceeded and the meter became excessively slow at 100% overload, meters are now designed which have a nearly straight line characteristic up to 200% overload and more. A considerable reduction in the full load speed and consequently in the self-braking torque has contributed largely to the excellent performance of such meters and whereas meters in the past had full load disc speeds of the order of 35 revolutions per minute the modern overload type meter has a full load disc speed of approximately 15 revolutions per minute.

That such meters are of great value to a Supply Undertaking will be appreciated as not only are the number of meter changes, and sizes to be kept in stock, greatly reduced but the overall accuracy with which such meters will meter the domestic or industrial load is also greatly improved, e.g., a domestic load varying from a single lamp to a maximum appliance and lighting load cannot be metered effectively by a meter having a full load rating to suit the maximum or peak load of the installation. By

employing a meter of the overload type however the peak load can with impunity be considered as 200% overload on the meter and a meter rated at 1/3 of the capacity of the former type employed.

With such a meter it will be appreciated that on light loads a much higher degree of accuracy of registration can be obtained.

METER SELECTION.

Having dealt with a few factors governing the operation of an electricity meter and the corresponding requirements in the design to give satisfactory service we will now briefly consider the question of selecting a meter suitable for the circuit to be metered.

In the alternating current field we have the simple 2-wire circuit calling for a single-phase meter of suitable capacity, and the polyphase circuit which may be either three phase three or four wire and may call for meters connected directly in the circuit or in circuit with the secondaries of instrument transformers.

As regards single phase meters no particular problem presents itself. The maximum load allowed by the Supply Undertaking on a two-wire supply will fix the upper limit of the current range on which the single phase meter will have to operate and in the majority of cases a 5 or 10 ampere (nominal rating) meter of the overload type will cover all requirements.

Where polyphase circuits are concerned, however, we find that while there is a meter which in theory will meter the circuit correctly under all conditions there are also numerous types of meters which are theoretically only correct when operating under certain conditions of voltage, current and power factor. A safe rule is to select a meter of the former type for unless the conditions peculiar to the requirements of the second class are definitely established serious errors in metering may arise.

To illustrate this point we will consider the two principal polyphase circuits, viz. the three phase, three wire circuit and the three phase, four-wire circuit. In metering the former a meter operating on the two watt meter principle is theoretically correct for all conditions of load and no errors are introduced if the current, voltage, or power factor is unbalanced.

The two element polyphase meter with independent potential and current circuits for each element meets this case and if the torque and inductive load adjustment of the individual elements have been correctly set the meter as such should be quite satisfactory.

In the opposite class we find meters having only one element (one current and one potential coil) and an inherent constant of $\sqrt{3}$ in the gearing of the dial train, meters with two current and one potential coil and so on. All these meters will record correctly only if certain conditions such as uniformity of phase voltages, currents and power factor are maintained, and while it is true that there are certain types of inherently balanced loads, e.g., motor loads consisting of polyphase machines only, which might be metered by this type of meter yet the fact that their registration is based on an assumption can never be overlooked in the event of any dispute arising over their registration and in view of the comparative slight extra cost of the two element meter there is really no sound argument for a compromise.

In the three phase, four-wire field we have the three element meter with three independent current and potential coils which entirely complies with the theoretical considerations required for correct metering and the so called split coil two element polyphase meter with three current and two potential coils. The assumption here is that the potential is exactly balanced and as this condition can never be guaranteed especially at points far removed from the feeding centre, the practice of using the three element meter is sound.

It is true that the three-phase four wire two element meter will register quite satisfactorily when the voltages remain balanced and such meters are effectively used on supplies in close proximity to a feeding point or on supplies fed directly from a sub-station but for service in factories or dwellings in a scattered community they are more than likely to be a source of trouble to the meter engineer.

That the errors of a split coil meter can be appreciable is apparent from theoretical considerations which indicate an error varying between 5% slow and 4.5% fast where the voltages of the circuit are unbalanced to the extent of 5%. The currents being assumed balanced and the power factor of the circuit equal to 60° Lagging. With unbalanced currents these errors may be consideably increased.

INSTRUMENT TRANSFORMERS.

Where instrument transformers have to be introduced in a metering circuit it must be borne in mind that the degree of accuracy with which the circuit is metered is now a combination of meter and instrument transformer errors and although the meter can be regularly tested and adjusted the instrument transformers are not likely to share in these tests. In the majority of instances continuity of supply and circuit conditions make it well nigh impossible to carry out service tests on instrument transformers when once installed. Great care should be exercised therefore in the selection of instrument transformers and only those of reliable make and high grade accuracy should be considered. The requirements of the British Standard Specification is a useful guide and where current transformers are concerned a rating of 15 volt amperes and Class B. accuracy are advisable. It is essential, that the errors of all instrument transformers should be determined accurately before the transformers are put into service and if such tests cannot be carried out by the Supply Undertaking they should obtain certified copies of tests

from the makers. The errors, if appreciable should then be allowed for when calibrating the meter(s) to be used in circuit with the transformers and also in successive service tests.

Instrument transformers unless subjected to gross abuse (such as heavy overloads or an open circuited secondary in current transformers) are highly reliable in their performance. Should there, however, be any occasion to suspect their treatment, a re-test should be made without delay. A momentary open circuit in the secondary of a current transformer may be sufficient to impair its accuracy as apart from any damage which may be caused by the excessive voltage generated in the secondary circuit, the reclosing of this circuit (or the switching off of the primary circuit with an open circuited secondary) may leave the core in a highly magnetized state which if not demagnetized will definitely alter the characteristics of the transformer.

In passing it may be mentioned that a simple means of de-magnetizing such a transformer is to pass an alternating current through the primary winding leaving the secondary open circuited, and gradually reduce this current to zero.

METER MAINTENANCE.

The limitations of the present article precludes the possibility of dealing with meter maintenance in any detail. It is felt however, that mention should be made of the following points.

Assuming a meter of reliable make, accurately adjusted, suited for the circuit to be metered, and last but not least installed with due care, we have the essentials for a good start.

INITIAL INSPECTION.

After the meter has been in service for about a week the initial inspection should be made.

This inspection is of primary importance and should on no account be carried out in a casual manner.

A capable person other than the meter erector should be entrusted with this task and needless to say all the results should be recorded carefully for future reference.

The points to be noted are as follows :

General.

(1) That the meter does not record when there is no connected load.

(2) That the minimum load on which the meter records is satisfactory.

(3) That the consumption recorded during the period the meter has been in circuit is reasonable for the use to which the service has been put. This check is of particular importance where instrument transformers are used, and in such instances every endeavour should be made to obtain a definite check against some independent source of metering. This may be the registeration of sub-meters either temporarily or permanently installed (in the low tension circuits where high tension metering is employed) or failing this a short duration check should be made against a consumption calculated from the readings of ammeters and voltmeters whose readings have been taken over a definite time interval—due allowance being made for the power factor of the circuit where this is other than unity.

Polyphase Meters.

The additional points to be noted here are :—

(a) Three phase three wire meters—if direct connected :

(4) That the phase rotation is correct, i.e., that the lagging element is connected to the lagging phase.

and where instrument transformers are used :—

(5) That the current and potential applied to each element correspond.

(6) That the polarity of each secondary current is correct.

(b) Three phase four wire meters—if direct connected :

(4) That the voltages on the line terminals are in order.

(5) That the phase rotation is correct. (where the type of meter in use is affected by phase rotation).

and where current transformers are used :—

(6) That the current and potential applied to each element correspond.

(7) That the polarity of each secondary current is correct.

In addition in all cases where instrument transformers are used the meter dial constant should be checked for correspondence with the ratios of the instrument transformers in use.

ROUTINE INSPECTION AND TESTS.

The meter having successfully passed the initial inspection should now be subject to a definite system of maintenance and the following suggestions are made :—

(a) The monthly readings should be carefully scrutinised and any abnormal increase or decrease immediately investigated. Should no ready explanation be forthcoming the meter should be tested and the accuracy determined.

(b) After the elapse of a definite period of service a routine test either "in situ" or in the testroom (whichever is the more convenient) should be made and the meter cleaned and re-conditioned if necessary.

The extent of the above-mentioned period will depend on the trustworthiness of the meter in use and the amount of energy which the meter records. A period of three years for single phase and direct connected polyphase meters, and three tests per annum for large supply meters should prove satisfactory. Meters for large supplies will, in the majority of cases, be in circuit with the secondaries of instrument transformers and as test links will no doubt have been provided the carrying out of routine tests at frequent intervals presents no difficulties. Furthermore it should be noted that meters which are known to develop defects should receive greater attention, e.g., in the case of direct current meters, a yearly inspection and test may be necessary.

In order to carry out the inspection, and tests mentioned above the following equipment is recommended :—

(a) For direct connected house-service meters:

A voltage tester of the pocket type or alternatively two B.C. Lampholders wired in series and having suitable leads. By using miniature lamps (illumination type) of 15 or 20 watt rating, compactness is secured and pressures of 220 or 380 volts can be determined with ease.

The starting load can usually be checked by switching on one or two lamps in the installation to which the meter is connected. in certain cases, however, such as meters installed on power circuits, etc., a load sufficiently low in wattage cannot be ob-

tained and the use of a portable load consisting of two lamps say of 40 and 60 watts rating connected in parallel and installed in a small box, will be very useful.

(b) For three phase three wire and instrument transformer connected meters:

(1) An alternating current voltmeter with suitable ranges.

(2) A phase rotation indicator—(a simple device based on a method due to Varley can readily be constructed—details being given in the Appendix.)

(3) A Power factor indicator.

A single phase portable instrument is now on the market which will indicate correctly the power factor of a circuit irrespective of the polarity of the connections to the current and potential circuits of the instrument. This feature is of particular value in the correct determination of power factor as the bogey of doubt as to the accuracy of the connections is completely eliminated.

(c) For routine tests.

(1) One or more rotating substandards with suitable ranges.

(2) A load box either of the resistance or of the so-called phantom load type.

As there are several points in favour of using the latter type, details have been given in the Appendix of the phantom load box made in the Test Room of the Capetown Corporation's Electricity Department. The weight of the complete apparatus is about ten pounds, the overall dimensions being 7" x 7" x 5".

CONCLUSION.

Only by introducing and adhering to a definite policy of meter maintenance can a Supply Authority guard its revenue and inspire confidence in its consumers.

As stated at the commencement of this article the modern meter gives excellent value for money, but there is a reservation to this statement—viz : provided a good quality meter is selected and provided that its accuracy is initially established and watched. Where this proviso is neglected a state of false security may readily replace a definite knowledge of the true state of affairs—so "know thy meters."

Appendix.

PHASE ROTATION INDICATOR (Figs. 1 and 2).

Two clear glass 220 volt 20 watt Lamps (R and B, Fig. 1) and an inductance L consisting of a 220 volt A.C. meter potential coil are connected as shown. The apparatus is mounted in a small box and three leads r, w, b, coloured red, white and blue respectively are used to connect the device to the supply under test. The lamps R and B should be distinctly marked red and blue either by a disc adjacent to the holder or by means of a circular spot of paint on the glass.

By applying the leads r, w, and b to the terminals of a three phase supply say A, B, and C. (Fig. 2) if with r on A, w on C and b on B ,the lamp B glows more brightly than lamp R, then the phase rotation is as indicated by the arrow, i.e., A is the leading phase and B the lagging phase. The rule is that the bright lamp is connected to the phase lagging in respect to the phase to which the dull lamp is connected. It is to be noted that this device will serve both for 380 and 110 volt three phase circuits.

PHANTOM LOAD (Fig. 3).

This device consists essentially of a small transformer having its primary connected to a 220 volt supply and its secondary to the meter under test. In order to vary the current drawn from the secondary a tapped resistance (R—Fig. 3) is connected in series with the external circuit. The tappings are brought to six terminals as shewn and the values of the resistances are so chosen that currents varying from 1.25 to 10 amperes are obtained.

With this arrangement either 5 or 10 ampere meters can be tested at $\frac{1}{4}$, $\frac{1}{2}$ and 1/1 load, the connections for the respective loads being as under.

5 Ampere Meters.	**10 Ampere Meters.**
C & 4—Full load.	C & 1—Full load.
C & 5— $\frac{1}{2}$,,	C & 2— $\frac{1}{2}$,,
C & 6— $\frac{1}{4}$,,	C & 3— $\frac{1}{4}$,,

The core of the transformer is rectangular in shape having a cross section $\frac{3}{4}$" x $\frac{7}{8}$" and measuring 4" x 3" on the outside.

The primary (P) consists of approximately 1,800 turns of No. 26 S.W.G. wire wound on one limb and the secondary (S) of 80 turns of No. 14 S.W.G. wire wound over the primary. With the primary connected to 220 volts A.C. approximately 10 volts are developed across the secondary terminals, and a maximum resistance of 5 ohms (terminal 6) will be needed to obtain the lowest current (1.25 amperes). The whole of the apparatus is mounted in a teak box measuring 7" x 7" x 5", the terminals 1 to 6 and C being mounted on an insulated panel above the transformer. A hinged lid protects these terminals when not in use.

A and B are two small sockets (5 ampere type) mounted on the side of the box, the connections to these being made by two pin plugs as shewn in the diagram.

The President said their thanks were due to Mr. Eastman for reading this paper, and they would like him to convey their thanks to Mr. Albertijn for his most interesting contribution which dealt with a very important subject. (Applause).

Mr. Rodwell (Johannesburg) said Mr. Albertijn had struck the right note in his opening remarks by stating "A distinction, however, must be drawn between the meter which superficially may appear to be a sound proposition but which only by continually coaxing can be held to the 'path of virtue' and the high grade meter which faithfully continues to record the energy delivered although neglected for lengthy periods, etc."

Too great stress could not be made on this point. Cheap meters were a false economy and a continual source of dissatisfaction to the supply authority, the test engineer and the consumer. Its maintenance costs were high, and its useful life period very short. On the other hand the high grade article was not only a sound engineering proposition, but measured correctly each year electrical energy worth much more than the meters prime cost and was good for very many years' service. Hence it became a very sound financial proposition.

The improvement in A.C. meter design and performance in recent years had been outstanding. Considerable alterations had been made in many leading makes, exemplified by lightening in construction, greater accessibility provision of easy adjustment and simplifying assembly. Another feature of recent development was the design of a meter capable of carrying a continuous overload of 100% without impairing its accuracy. These meters seemed to be gaining popularity overseas.

The salient points mentioned by the author were very sound.

PHASE ROTATION INDICATOR

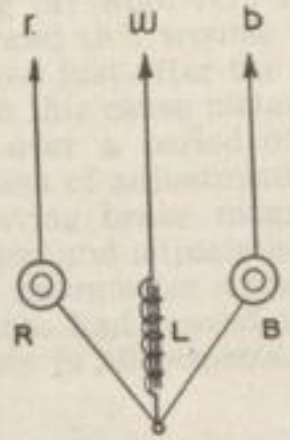
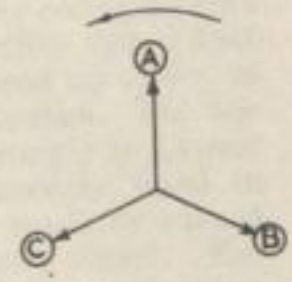


FIG. 1.



BRIGHT LAMP
INDICATES LAGGING PHASE

FIG. 2.

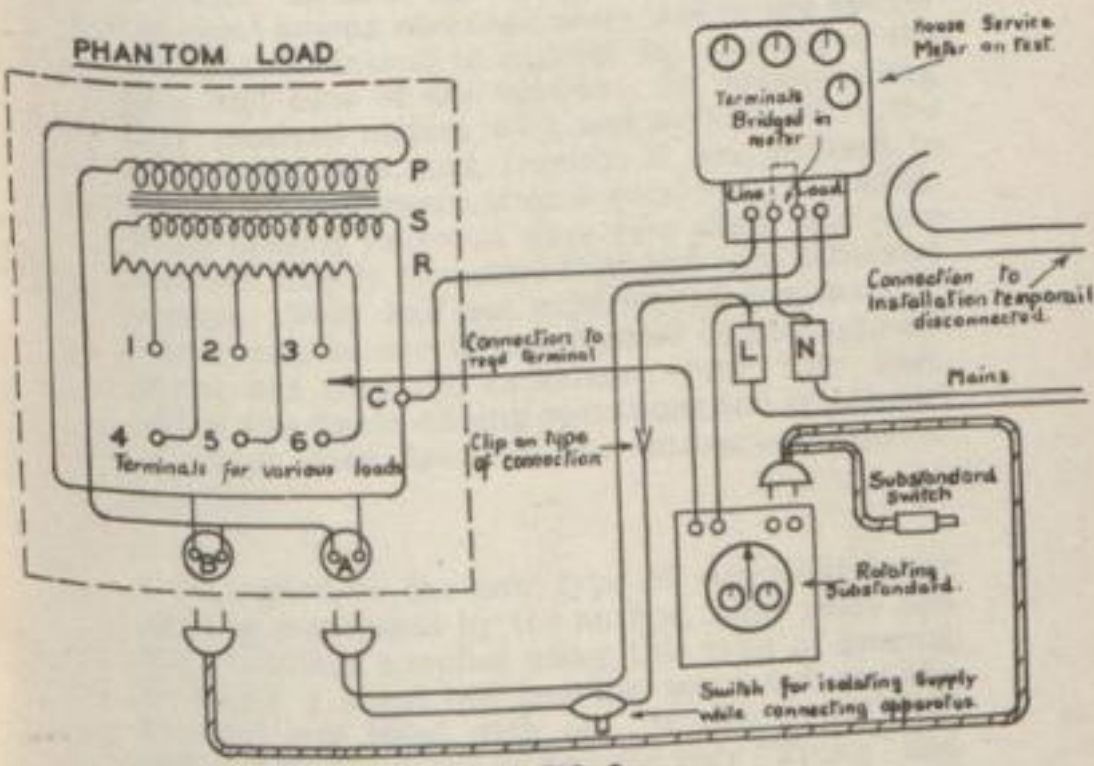


FIG 3

INTERNAL CONNECTIONS OF PHANTOM LOAD & METHOD OF CONNECTING FOR METER TEST "IN SITU."

(a) On the question of brake magnets he was in entire agreement with the author. Makers of high grade meters were paying special attention to the brake magnets and instances of magnets falling off were very few indeed. They had experienced this trouble especially in consignments received just after the war, when they found that due to this cause meters would speed up to 6% to 10% over a period of twelve months. On the question of adjustment he was strongly in favour of having brake magnets permanently fixed in position and adjustment of speed made by means of a micrometer type of magnetic shunt. Experience had proved this type to be most satisfactory in all respects.

(b) He did not think there had been any feature of the meter that had been debated more keenly than the question of using oil in the bottom bearing. Even to-day there was no unanimity on the point among manufacturers, and he did not for one moment intend to express any opinion on the pros and cons of the subject. In Johannesburg they received meters with and without oil in the bottom bearings, and, frankly, it was difficult to detect any difference after several year's running. Their bearing renewals were very slight and were confined mostly to meters that had seen extensive service. They had not experienced any cases of rust, probably due to the dryness of their atmosphere, but they did experience very fine dust, which was due to mining operations and on account of which they favoured the dust-proof type of bearing.

In regard to the new type of American lower bearing mentioned by the author, some years ago they obtained supplies using this type of bearing in which a small ball bearing was used and the bearing cup filled with oil. It was found that within two years the oil became very "Tacky" and caused the meters to slow down. In Johannesburg, however, in spite of all the controversy on the subject, they did use oil.

(d) In addition to the points mentioned by the author under this heading, their experience had definitely proved that so far as Johannesburg was concerned the brass friction tight worm on the armature spindle was entirely unsuitable. Some years ago a very large consignment of meters with this type of worm were purchased and placed on circuit without suspicion of the fault. Within three months, owing to numerous complaints of non-registration, a careful investigation was made, and it was found that these worms were working down the armature shaft and out of mesh with the dial train. The fault was cured by soldering the worms in position. Even as recently as last month samples of meters submitted for test with the same class of worm were found to be loose on their shaft. So far as the fixed meshing dial was concerned while all were designed to meet a definite need, some designs were outstanding. Cyclometer dials had not proved satisfactory, and they had standardised on the pointed dial, but the workmanship and material used should be carefully examined.

(e) Under this heading the only debatable point to his mind was the advisability of an old established supply authority with many thousands of 5 and 10 ampere meters on its system going in for new straight line meter, which was capable of registering correctly up to 200% load as against continuing to use meters of a definite capacity. He did not decry the new meter, and could forsee its adoption by numerous smaller companies with satisfactory results, but in a large undertaking where a regular policy of periodic changing for reconditional purposes was carried out, the danger of putting in an ordinary 10 ampere meter in place of a straight line meter which had been carrying a heavy overload was so great that the policy became doubtful. He did think, however, that under modern conditions where so many electrical appliances were available for the household that the day of the 5 ampere meter was over, and that

the lowest rating should be the 10-15 ampere size. With the high grade meter of these sizes its accuracy was such that it picked up correctly even the lowest load.

Coming to the question of selecting the most suitable meter, Mr. Rodwell said that in the single phase meter, in addition to the points already enumerated they must consider the cost of maintenance. The most satisfactory meter in their experience was one in which the unit, consisting of rotor, brake magnets and dial assembly could be removed from the case, leaving the electrical element fixed in the case. As all parts (including the bottom bearing and top guide) had a definite fixed position, they could be removed, examined and replaced without affecting the calibration. A careful test on a set of tested meters of this type after complete dismantling of the parts mentioned and reassembling revealed the majority to be within .2% error and one had an error of .5%. The advantage of this type of meter when inspecting in situ was obvious.

In connection with polyphase circuits the author was quite sound and the best policy was to get the right meter for the job.

The author's comments on meters working off instrument transformers were essentially sound. He (the speaker) often thought that these points were not fully appreciated, and he was pleased to note that the author recommended Class B accuracy, 15 volt ampere rating. The practice in Johannesburg after checking ratio and polarity was to test and adjust the meter on transformers, record its degree of accuracy and then test the meter as a 5 ampere meter and also record its degree of accuracy off transformers. These records were carefully noted, and, in the event of trouble, a new meter tested off transformers to the required degree of accuracy could be installed without shutting down the consumer, naturally shorting the secondary side of the transformer before starting operations.

While on the question of current transformers, it was to be regretted that B.S.I. did not insist that the secondary terminals should be brought out to a well-designed terminal box, with an automatic self shorting device when the terminal cover was removed, the terminal box to be kept sealed.

The author's remarks on meter maintenance were all to the point. He (the speaker) could appreciate Mr. Albertijn's limitations on the subject. It was a very large subject, but he thought if the author had gone more into detail it would have been greatly appreciated, especially by the engineers of the smaller undertakings.

The device for phantom loading was extremely useful, and a similar device, but worked off a selector switch having ranges from 20 watts rising in 20 watt steps to 100 watts, and then on in .5 ampere steps was in general use at Johannesburg, and had proved very successful, especially to meter mechanicians cleaning and reconditioning alternating current meters.

They had to thank Mr. Albertijn for his instructive and useful paper. (Applause).

Mr. Foden (East London) said that although the author favoured the practice of using a three element meter in preference to a two element meter in 3-phase, 4 wire circuits, was it not true that a certain amount of interaction occurred in the 3 element meter which was not present in the 2 element meter, which interaction affected accuracy? This was particularly so in meters not of reputable manufacture.

There were meters available counteracting this interaction by means of a complete magnetic circuit enclosing the series and shunt magnetic system. Had the author found this perfectly effective? Did the author agree with the practice that where meters were bought in batches, final payment to the suppliers should be witheld until the meters had passed an acceptance test?

Mr. Sibson (Graaff Reinet) said he would like to add his thanks to those already given to Mr. Albertijn for his interesting and able paper. He was particularly glad to note the author's remarks anent the necessity for regular tests of meters during their normal life. Mr. Albertijn had mentioned the two principal reasons for such tests, viz., the question of revenue and the goodwill of the public. His reference to goodwill was from the angle of possible excessive charges, but the opposite was equally important. During the last few months at least four small towns had gone through the agony of a change over from D.C. to A.C. associated with a clean sweep of old meters and the installation of new ones. In each case an uproar had resulted when it had become evident that the new meters gave considerably higher registrations. Protest meetings had been held and widely-signed petitions presented, and it had been extremely difficult for engineers and councillors to convince consumers of their good fortune in the past and to induce a sense of satisfaction with the new conditions (Laughter). In Graaff Reinet, where in March the change over was effected, they had 800 consumers largely served by 5 and 10 ampere meters, and it soon became clear that the difference in registration was to be an important factor in regard to the goodwill of the public. In order to make the matter clear, a number of meters were selected at random, and the following test results obtained on the usual light load test of 20 watts :— 8% did not move at all., 25% were more than 100% slow, 30% were between 50% and 100% slow. 20% were between 25% and 50% slow, and the balance were between 0 and 25% slow. (Laughter). He gave them figures as they might be of interest to those contemplating a change-over in the near future. (Applause).

Mr. Councillor Fowkes (Cape Town) said that as a mere councillor with no pretensions whatever to any expert or technical knowledge of the matter under discussion, it would be unwise for him to express any opinion on any of the technical points that had been raised in Mr. Albertijn's able and

instructive paper. But there were one or two implications from the commercial side which might be worth while considering. The installing of accurate and reliable meters was of the utmost importance seeing that the meter was the principle connecting link between the manufacturing and the sales side of the organisation. As the retiring President had remarked, "future load building must come from the domestic consumer," and he thougnt they would all agree that it was extremely desirable to obtain the confidence and goodwill of the consumers, who should have every confidence that the meters installed would accurately register the current consumed by them and for which they would have to pay. It seemed to him that a certain amount of publicity propaganda in regard to the reliability and accuracy of the modern meter might be of advantage in helping to build up that goodwill and confidence. In that connection they had to bear in mind that they had to secure the goodwill of the housewife. As a general rule women were to some extent afraid of the possible dangers arising from the use of electricity. It was part of their duty to try and remove these misconceptions, and to give consumers every confidence that they would receive good service from their electrical appliances. The Women's Municipal Association in Cape Town had approached them with a view to organising a series of lectures on the use of electricity, including the remedying of minor faults. This showed that women to-day were becoming alive to the fact that electricity could do everything in the home that was claimed for it, and from that point of view Mr. Albertijn's paper was not only very opportune, but also very interesting. (Applause).

Mr. Dwyer (De Aar) said, Mr Albertijn was to be congratulated for an excellent presentation on the all-important subject of meter maintenance. His experience had been that the servicing of meters was not given the consideration it should have, and he hoped that the author's interesting paper would attract the attention of all those concerned with the desirability of regular inspec-

tion of all meters. In most of the smaller schemes the purchase of accurate testing equipment was out of the question in view of its high initial cost, but he was sure that by following the suggestions contained in Mr. Albertijn's paper, losses would to a large extent be obviated. Mr. Sibson had quoted figures of tests taken on D.C. meters after a change-over, and he could bear Mr .Sibson out that they were not exaggerated. Results of his (the speaker's) tests revealed more or less the same result when he completed the change-over at De Aar twelve months ago. (Applause).

Mr. Metelerkamp (Bulawayo) said that Mr. Albertijn very ably and concisely stated the importance of metering in any undertaking. He has illustrated the fallacy of purchasing meters on price.

A point of particular interest in the paper was the inaccuracy of the 2 element split coil meter under certain conditions as compared with the 3 element 3 coil meter. The author has justified his statement "that the use of 3 element meters is sound," though approximately 80% higher in price.

The points as raised regarding the accuracy curve of meters demonstrate the advantage of a 4 wire service for domestic consumers.

Mr. Clinton (Salisbury) said that having at one time worked as an assistant to Mr. Albertijn, he was in a position to appreciate the immense amount of work he had put into his paper. He had stressed the point of purchasing meters from reputable makers, but even then dangers arose, and it was still necessary to carry out periodic tests to determine whether a meter was playing the game. He remembered an incident of a meter of beautiful make, but owing to an alteration in the design a very serious fault developed, a fault which, if he remembered aright, was to the advantage of the undertaking. This defect was not discovered for some considerable time. For that

reason the remarks on page 107 of Mr. Albertijn's paper were of tremendous importance. Meter maintenance cost money and it was for engineers to determine what were the economics of meter maintenance. The author mentioned three years as the limit beyond which one should not go without testing a meter. He would like Mr. Albertijn to give them figures and a census of tests carried out periodically at Cape Town. Such figures would be highly appreciated by members generally. Another point was the correctness of the Varley test under all conditions. He had used it for some time and believed it was not always correct.

Mr. Councillor Phillips (Salisbury) fully agreed with Mr. Hassett. Control was necessary, not only in regard to installations, but also repairing work which could now be done by any Tom, Dick or Harry.

REPLY TO DISCUSSION.

Replying to the discussion Mr. Eastman said that with regard to the rating of meters they had in Cape Town standardised on 15-ampere 3-phase, 3-element meters of 150% rating and 10-ampere, single-phase meters of 300% rating. Very few 2-element, 3-phase meters were in use for the reason that, with the exception of high tension bulk supplies, all 3-phase supplies were given on the 3-phase, 4-wire system, on which system the the 2-element meters could not be trusted to give accurate results. In Cape Town every care was taken to eliminate as far as practicable any possibility of justifiable complaints regarding meter accuracy being raised by consumers, and since the present-day system of routine testing was introduced some years ago the number of complaints of inaccuracy had fallen off very greatly notwithstanding the enormous increase in the number of meters used. This went to show that a system of careful meter maintenance not only safeguarded the revenue of the undertaking but showed also the extent to which it ensured the

goodwill of the public. Goodwill was prized above everything and the Council was prepared to pay for it, realising that money spent in this direction came back again. The split-coil types of meters mentioned by Mr. Meterlekamp was not used because they were inherently not as accurate as the 3-element meters on a 3-phase, 4-wire system of supply. Experience in Cape Town was that the accuracy of high grade A.C. meters did not vary to a very great extent within the useful life of the meters, and he laid upon the table data of tests results in this connection.

Mr. Horrell asked Mr. Rodwell whether in Johannesburg they had experienced any difficulty caused by lightning in regard to 3 phase meters?

Mr. Rodwell replied that he had never heard of any effects from lightning. The fact that the cables were all underground would make a difference.

Mr. Harvey : At Springs we have all single phase meters with overhead connections, and we have never experienced any trouble with lightning.

Mr. Damant (Natal Inst. Engineers) regretted very much that he was unable to be present at the opening session of the Convention. He appreciated the invitation extended to the Natal Institute of Engineers, and had listened with great interest to Mr. Albertijn's paper. He congratulated the author upon the lucid manner in which he had dealt with **the question of meters** and their maintenance. One or two points, however, might have been enlarged upon concerning the nature of the testing apparatus. This would have been very useful to the smaller undertakings. The matter was one of economics and the problem was to ascertain how much or rather how little to spend in order to obtain a maximum benefit. He believed that in Cape Town the normal period for testing was three years and he would like to know how this particular period was arrived at, and if it could be applied generally. If not would the

author give an indication as to how often tests should be carried out in small undertakings? He had had experience of high-class meters that had been in commission for eight years, and they were as accurate to-day as when they were first installed. That indicated that for some types of meters it was not necessary to test and overhaul every three years. He again thanked the Convention for its invitation to the Natal Institute, and hoped the Association would long continue to co-operate with that body. (Applause).

Mr. Jagger (Ladysmith) referring to Mr. Horrell's question regarding the effects of lightning on meters, Mr. Jagger said that in Ladysmith they were subject to very severe thunderstorms and after the change over from a Direct Current supuply to an Alternating Current supply it was found that a large number of meters were being damaged by the lightning surges on the Supply Mains. To overcome this trouble a simple lightning arrestor device was connected to the consumer's service lines and the result has been very satisfactory, not more than three or four meters being damaged by lightning in a year.

Mr. Ralston (Dundee) agreed with those speakers who had pointed out that in the smaller towns there was great difficulty in getting Councillors to understand the necessity of accurate instruments for testing purposes. Whilst some Councillors did not mind giving Civil Engineers £2,000 for odd jobs when the poor Electrical Engineer needed £200 for testing apparatus there was always a demure. If Councillors would take the view that in order to protect the revenue side of their electricity undertakings it was absolutely essential that their meters should be tested in an efficient manner, he thought that they would provide some instruments.

Mr. Brown (Volksrust) thought the provision of testing instruments should be included in the original scheme submitted by the consulting engineer, otherwise there was no hope of their getting the instruments they required.

Mr. Eastman, replying further to the discussion, said that it was evident that the problems of the smaller undertakings were different from those of the larger ones in regard to the maintenance of meters and testing equipments. He was unable to answer the question as to what time should elapse between tests in smaller undertakings, but he put forward the suggestion that it should be made as short as possible. He undertook to convey to Mr. Albertijn the request for suggestions concerning meter testing equipment suitable for the smaller undertakings. Replying to the question raised on the accuracy of new meters, he stated that a recent test of 4,483 new meters showed that 3,572, or 79.7%, were within the limits of a tolerance of plus or minus 2%, 3 did not record at all, 4 were more than 2% slow and 904 were more than 2% fast.

The President : I am sure you would like to accord Mr. Eastman our thanks for his remarks, and also to thank Mr. Albertijn for his paper, which has resulted in such a profitable discussion.

REPLY TO DISCUSSION.

communicated by Mr. Albertijn.

Mr. Foden (East London) raises the point as to whether the interaction in a three-element meter was not greater than in a two-element meter, and affected the accuracy.

As the elements in a three-element meter are usually in closer proximity than those in a two-element meter the possibility of interaction is greater.

Makers are, however, alive to the unwanted straying of the magnetic fluxes from one element to the other, and there are several three-element meters on the market which are so designed as to reduce interaction to a minimum.

The type where a complete magnetic shunt encloses the series and shunt magnetic systems of each individual element, and also the type where the centre part of the disc is composed of an insulating material leaving only an annular metallic ring rotating between the poles of the element, was found to be satisfactory.

Regarding the controversy as to the preferability of two or three element meters, the following extract has been taken from an editorial article in "The proceedings of the Meter Engineers Technical Association" (England) of March 1928, may be of interest :—

> "There are four methods available for metering a three phase four wire circuit, viz. :—
>
> (a) Three single phase meters;
>
> (b) A three-phase four-wire three-element meter;
>
> (c) A three-phase, four-wire, two-element, split-coil meter;
>
> and;
>
> (d) A three-phase, three-wire, two-element meter used in conjunction with three current transformers with their secondaries connected in delta.

The results of an investigation as to which method is the best were published in an article which appeared in the 'Electrical Review' of April 9th, 1926, under the title "Three Phase Four-wire metering," and seemed to prove that methods (a) and (b) were equally satisfactory from the point of view of accuracy but that (b) possesses many points in its favour and is to be recommended. Methods (c) and (d) were proved to be extremely inaccurate under certain conditions and were in consequence ruled out as being unsatisfactory.

In the 'Electrical World' of January 14th, 1928, an exactly similar verdict is given in an article "Four-wire Metering," which is based on data obtained from experiments carried out by the Meter

Department of the Memphis Power & Light Company, U.S.A., and, as a direct result of these experiments, the Company which operates an extensive three-phase four-wire network finally decided to adopt the three-element meter as standard.

In conclusion the Editor comments "That it is interesting and significant to note that at least two undertakings in this country at which similar investigations were made came to precisely the same conclusions, and likewise adopted the three-element meter."

Regarding the payment for new meters, the purchaser would have to be guided by the quality of the goods and the standing of the manufacturer.

If there was any doubt as to the quality of the meters as a whole or any component part thereof, or if there was a possibility that defects due to assembly might exist, it would certainly be advisable to withold the final payment until the purchaser was satisfied that all meters were satisfactory.

On the other hand, where large quantities of similar meters were purchased from a manufacturer of repute, it might be uneconomical to the purchaser and cause unnecessary delay in payment if all the meters were tested before settling the account.

During the period of delivery there is usually ample time to test a large percentage of the meters delivered, and no difficulty should be experienced when dealing with a maker of repute to obtain replacements for defective meters or parts which might be found subsequent to the date on which the final payment for the complete consignment had been made.

It is the practice with the Electricity Department of the City of Capetown to call for a makers' test sheet with each meter supplied. This ensures that each individual meter will be tested by the

maker before shipment, and the possibility of defective meters being shipped is thus guarded against.

Mr. Clinton (Salisbury) raises the point as to the correctness of the Varley Test under all conditions.

It is not quite clear what conditions Mr. Clinton refers to. The phase rotation indicator described in the paper will not indicate the phase displacement of the terminals to which it is applied., eg., whether applied to a three phase three wire supply or to a two-phase three wire supply a bright and dull lamp will still result.

Provided however, that the correctness of the voltages on the terminals has been initially established by independent means, then there can be no doubt that the phase rotation will be correctly indicated by the glowing of the lamps—this from theoretical considerations.

Mr. Damant (Natal Inst. Engineers), requests further information regarding the period for carrying out routine tests.

At present a period of three years was adhered to for single phase meters, as experience had shown that certain makes of meter required adjusting at the end of this period.

No hard and fast rule can however be laid down, and the routine testing period should be chosen to suit the type of meter on service. As Mr. Damant points out, certain meters will, after eight years service, still be quite accurate, and a period considerably in excess of three years could be fixed for meters of such a type.

In 1927 a committee was set up by the Meter Engineers Technical Association (England) to investigate the question of Periodical Meter Testing, and from the replies received from 25 members

attached to Electricity Supply Undertakings, the Committee's recommendation for the time intervals between periodic tests was as follows :—

(1)	A.C. Meters—Single-Phase	5 years
(2)	A.C. Meters—Polyphase	
	Capacities up to 50 K.V.A.	3 years
	above 50 K.V.A.	1 year
(3)	D.C. Meters—Mercury-Motor Type	4 years
(4)	D.C. Meters—Amp-hour Commutator Type	1 year
(5)	D.C. and A.C. Meters—Clock Type	
	Capacities up to 50 K.V.A.	7 years
	above 50 K.V.A.	1 year

No recommendation was made with regard to Watthour Commutator type meters; it was considered that their use for house service work (including large consumers) was either confined to users who adopted their own special construction or otherwise too restricted to render a general recommendation practicable.

Although the above may be taken as a guide it should be noted that statistical records of meter accuracy should be the basis for determining the safe period during which a meter can be left in service without attention.

Moreover, as such records are bound to vary for different Undertakings (irrespective of whether they are large or small), the fixing of the routine test interval is best determined by each Undertaking individually.

STATUS OF ELECTRICAL ENGINEERS.

The President then read the following telegram from the Chairman of the Certificated Engineers Association :—

"Regret non attendance, circumstances weighed against me, hope Conference finds time to develop Engineer's Status."

Introducing this subject, **Mr. Rodwell** (Johannesburg) said he had been asked to do so for the purpose of discussion and a decision as to the steps, if any, the Association should take to improve the present position. They had seen advertisements in the press asking for applications for positions as electrical engineers to small towns at salaries of £25 to £27 10s. per month. It was, of course, absurd to suppose that fully qualified engineers would undertake the responsibilities of plant of £10 000 value and upwards at such salaries. Such action must necessarily result in the small towns receiving inefficient and unsatisfactory service and probably bad advice, ultimately mulcting the ratepayers in heavy loss.

At the annual dinner of the Certificated Electrical and Mechanical Engineers of South Africa, Dr. Hans Pirow referred to the closed professions, such as those of doctors, architects, etc., and suggested that it appeared reasonable that engineers should receive similar status for the benefit not only of themselves, but of those they served. Subsequently the glaring inadequacy of the present position had been brought to their notice through the press and by members of various engineering societies. Largely as the result of these representations the Associated Scientific and Technical Societies of South Africa had taken the matter up and had formed a strong committee to report to the main executive on the matter. The committee consisted of representatives from the South African Institute of Electrical Engineers and the South African Institution of Engineers.

He understood that it was the intention to cooperate with other bodies, such as the South African Institute of Civil Engineers, the Association of Certificated Electrical and Mechanical Engineers and others.

While many of their members were also members of one or other of these societies, he was of opinion that as an Association they should cooperate in every possible way. He therefore

moved that the Associated Scientific and Technical Societies of South Africa be communicated with and assured of the wholehearted support of the Association in their efforts to improve the status of the engineer by legislation for the benefit of South Africa as a whole. (Applause).

Mr. Ralston (Dundee) said he had been instrumental in forwarding the status of Engineers this little bit owing to the fact that he had made a contribution to a paper recently read on the subject, the author being Mr. Linderman. He was prompted by the advertisement in a newspaper for a certificated Engineer with a knowledge of all branches of engineering for a princely sum of £25 per month, and in the same paper was an advertisement for a Compound Manager at £40 a month with free house, free light, etc. He mentioned this point in the way of comparisons. They had Sanitary Inspectors who were earning £30 to £35 per month. Hence there was every reason why the Association should strive for the recognition of Engineers. (Applause).

Mr. Horrell (Pretoria) was glad this matter had been raised, he had occasion to refer to it in Johannesburg recently in connection with Certificated Engineers. As you are aware, there are two types of Engineers Certificates :—

(1) **That obtained by examination** and

(2) **That generally known as a "Service Ticket."**

In special cases where a man has been holding a position for some years, and the Government Inspector rules that the position which he holds requires a certificated engineer an endorsed certificate is given, i.e., a ticket for that particular post, and for that post only.

The granting of such certificates to unqualified engineers (which although endorsed for the post which the holder fills) does not add to the prestige

of the certificated engineer, and it is to be hoped therefore that the authorities will see fit to adopt a definite policy in the future.

Mr. Clinton (Salisbury) said he must apologise for his name being brought into the discussion without having had notice of the subject under discussion. In regard to the question of status, he felt that their value in the market places of the world was not going to be helped in the way Mr. Ralston imagined. Status was needed for the protection of the general public whom they served, and it would not improve engineers' remuneration until the public's opinion on the engineer's value changed. The public had a very poor idea of engineers generally, due to the fact that plumbers and others posed as engineers. Before they reached the stage of discussing details and qualifications he thought it essential to obtain recognition by means of a private bill to give engineers standing similar to that enjoyed by architects, accountants and others. In his opinion the drafting and promotion of a private bill would be by far the best course to adobt, and that such a bill should be first distributed to members. (Applause).

Mr. Harvey (Springs) thought the Association should write a letter to the Institute of Certificated Engineers requesting them to make representations to the Government to abolish the service certificate entirely. This subject was ably dealt with in a paper by Mr. Clinton, which covered the whole ground in a nutshell, and it was a pity that paper was not available at the Convention.

Mr. Milton (Elec. Supply Com.) agreed with Mr. Clinton but pointed out that the meeting should not lose sight of the factors which had to be considered when the "Ticket" was introduced by the Mines and Works Act of the Union, and in order that the position might be clear in the minds of those present, he reviewed the position as he understood it.

When the certificate of competency was introduced, it was fully realized by those in authority that many excellent engineers would have suffered considerable hardship had it been necessary for them to sit for a written examination. Certain concessions were therefore made in the case of well established engineers in charge of plant, and "Tickets" were issued in terms of the regulations (No. 292) to such men.

The regulation setting out the qualifications required for a certificate without examination was, however, insufficient to meet every case at the inception.

The "Service Ticket" enabled an engineer to take an appointment anywhere in the Union, but there was, however, a further class of engineer who in terms of the regulation required to be certificated but who would probably find it extremely difficult to satisfy the examiners of their competency in a written examination and at the same time was not qualified for a "Service Ticket."

In consequence, the authorities, in order to avoid imposing a hardship, decided to grant what are commonly called "Local Service Tickets" to men who had been in charge of plant of over 200 H.P. for a number of years and proved themselves competent, as it was felt that such men were competent to handle the plant with which they were quite familiar.

These "Local Service Tickets" entitled operatives to take charge of their own plant at the particular place in which they were employed at the time when the ticket was granted, but did not entitle these men to obtain a post anywhere else where a "Ticket" was required by Law. It was probably only natural that a certain number of "Service Tickets" and "Local Tickets" were granted to persons whom later experience may have shown as not being sufficiently qualified to hold such tickets.

At the present time, the only people entitled to "Service Tickets" are engineers who come into the country from overseas, as no engineer is in charge of plant of 1,000 H.P. in the Union who does not possess a "Ticket." Such men from overseas as might be granted "Service Tickets" to-day would naturally be men of wide experience and fully entitled to senior positions, and it did not seem reasonable that any argument should be put forward to compel such men to write examinations. In the circumstances, it appeared that to-day only such men as were fully qualified could obtain a "Ticket."

Mr. Milton further stated that some mention had been made of the practical experience of men writing for their "Tickets." In this respect the regulations provided that the Examining Board should satisfy itself that the applicant for examination had served an apprenticeship or pupilage in the particular branch of engineering for which the "Ticket" was required and that he possessed a sufficient knowledge of the construction, maintenance and operation of machinery which he would be entitled to control when in possession of the "Ticket" applied for. There was also a certain age limit imposed and certain requirements were demanded as regards ability, sobriety and general conduct.

This meant of course that, for example a University student could not go straight from the University to the examining Board and write the examination and so obtain his "Ticket" when in reality the student probably had no experience of the operation of plant or the control of men. It was reasonable to assume that if the Examining Board did its duty, certificates could only be obtained by men of sufficient experience.

Coupled with this question of certificates and the status of the engineer, mention had been made of the extremely low rates of pay which were offered by Municipalities to men whose status entitled them to far better remuneration, and the

remark had been passed that no Municipality could get a really fully certified or sufficiently qualified man to take a position at the low rates of pay offered. Unfortunately, during recent years there had been a glut of qualified men on the market.

Whilst the Commission had always urged that an engineer should be paid a salary commensurate with his ability, it had been told by more than one group of Councillors that really excellent men were available at the low rates of pay offered. Councillors had therefore asked why they should not endeavour to obtain the services of these qualified men as cheaply as possible.

It was all very well, said the Councillors, to say that they were not playing the game; the Councillors' first duty, however, was to obtain services for the Ratepayers they represented at the lowest possible cost to the Municipality.

In considering this question it seemed that the Convention was up against a very human difficulty, and the human aspect robbed the Association of the support which it should get from the ranks of qualified engineers. Qualified men in monetary difficulties especially when married and caring for a family, were inclined to disregard status in the interests of supplying accommodation, food and clothing for their families.

Mr. Milton hoped that his remarks might be of assistance in the further discussion of the question before the meeting, as it was as well to be warned of some of the difficulties with which the Association would be faced when pushing this matter forward.

Mr. Councillor McLean (Port Elizabeth) said a remark made by Mr. Horrell to the effect that councillors did not understand, brought him (the speaker) to his feet. (Laughter). If he might be allowed to say so, he had attended conferences of councillors, medical men, civil engineers, publicity agents and others, but never in the course

of his experience had he attended a conference like this one. He considered that electrical engineers were the most serious and quietest Municipal employees he had ever met (laughter).

In regard to status, they, as highly technical men should do all they could to raise it.

That morning they had heard another phase of the question. Yesterday they were told about the salaries paid in . . . . . and that morning Mr. Sibson and the member for De Aar supplied another answer, namely that every ten years the meters were tested and after the expiration of that period it was found that there was no revenue from them. (Laughter).

He had been a teacher for 32 years, and knew a little about certificates. So far as he was concerned he thought there was far too much value placed upon university certificates in regard to technical work (hear, hear). In his view it was essential that an Electrical Engineer should have an equal amount of practical as well as theoretical training.

As an Association they should strive with all the power they possessed to get themselves recognised and insist (even in small municipalities) that no person should be allowed to control an electricity undertaking, who was not competent both practically and theoretically. He congratulated them upon the serious way in which they had discussed municipal undertakings, but thought they should concentrate a little more upon improving their own status. (Applause).

Mr. Wright (Benoni) said there was just one point which appeared to be more important than service certificates for men who had held their jobs. A mechanical engineer came along, filled in a form, and no questions were asked regarding his knowledge of practical Electrical Engineering. In his own case he served an apprenticeship both as a mechanical and and electrical engineer. He

applied to take two examinations and in each instance received a reply to the effect that he was not eligible for a mechanical certificate. He applied again, and three days before the examination he received a letter saying that he had to interview the Chairman of the Board, whom he was able to convince that he was a fit and proper candidate. He sat for the examination, and was successful, but he knew of cases in which men, plumbers or anything else, got a certificate simply by sitting for the examination, and without any question being asked about practical experience.

Mr. Damant (Natal Inst. Engineers) said that in 1932 he had the honour and privilege of being the Chairman of the Natal branch of the Certificated Engineers Association, and in his Presidential Address he raised this very point. He pointed out that the various Societies were working quite independently of each other. In his opinion it would be to their mutual advantage for the several Societies to come under the control of the associated body. This matter had been now taken up and the Natal branch were pressing it forward. Good work in the same direction was being done in Johannesburg and elsewhere. If they wanted the matter to go further the other Societies should become interested, and by that means Engineers might attain the object they had in view. What was required was a general charter for Engineers, such as they had in other countries. It was with this idea in view that the Associated Societies were now working, and he hoped that members of the Association would co-operate to bring about this very worthy object. (Applause.)

Mr. Rodwell (Johannesburg) thought that the question of affiliating with other Societies was one that should be considered by the Association. It could best be left in the hands of the Council, and he moved that the council be instructed to go into the question of their possible affiliation with the Scientific Societies of South Africa.

Mr. Dwyer (De Aar) seconded.

Mr. Ross (Potchefstroom) said, It appears most unfair, especially to the overseas man who holds the "Board of Trade Ticket" which is acceptable and recognized in any part of the world and consequently more valuable than a certificate issued in this Country, yet, when holding both, to be offered even £30 per month. Surely, if the Government can insist on certificated men being placed in charge of certain plant, they should also insist on fair remuneration being paid for the services and qualifications called for, in the form of a minimum salary. (Applause).

Mr. Rodwell (Johannesburg) said he thought the position enunciated by Mr. Milton had been somewhat misunderstood. What Mr. Milton has said was perfectly correct that engineers from overseas had been granted tickets to work in South Africa. This, however, was only being done in regard to specialists in a certain line, and for which the required talent was not available in this country. He (the speaker) suggested that this was a very good thing indeed.

The motion was then agreed to unanimously, after which the Convention adjourned.

VISITS.

In the afternoon visits were paid to the Pietermaritzburg Sub-Station of the Electricity Supply Commission and also to Nestleés Chocolate Factory. A visit was also made to the Electrical Exhibition at the City Hall.

WEDNESDAY, 25th September, 1935.

The Convention resumed at 9.30 a.m. with the President in the Chair.

RELIEF OF RATES.

The President said that in connection with the question of the Relief of Rates, the Council at its meeting that morning, had decided to send out a circular letter similar to that sent out last year, and to draw attention to certain clauses in the Electricity Act.

Mr. Councillor Dely (Pretoria) said that as a Councillor he favoured the taking of profits from an Electricity Undertaking. He thought the Association were going beyond their province to suggest that the Government should be approached in regard to the matter. Such a proposal should emanate from the Town Councils who desired it and the Association should not touch it. Electrical Engineers of towns and cities should remember that they were official servants of the Municipal bodies, therefore any such suggestions should be submitted to the Town Councils and certainly not go to the Government.

Mr. Councillor McLean (Port Elizabeth): On a point of order—is it the intention to send it to the Government?

The President: No, but to send it to the Administrators of each of the four Provinces (Mr. Dely—same thing) and to the various Corporations. I think the point is that Councils hold the view that Electricity must be supplied as cheaply as possible, and it is intended to send a reminder of that.

Mr. Councillor Dely (Pretoria) said this was a matter of municipal policy. It should not be forgotten that the Councils had to maintain other services, some of them at a considerable loss, and

he did not think any Municipal Council would resent such a resolution as suggested, he thought it would probably be ignored. Was it advisable for a body like this to put forward suggestions that would be ignored?

Mr. Councillor Fowkes (Cape Town) said he was sorry as a brother Councillor that he could not agree with the previous speaker. He did not think any of them were against an electric light undertaking contributing a certain amount of any profit it might make for the Relief of Rates but he did agree with the suggestion made by the Council that they should try and keep that contribution within reasonable limits. It had been said, he could not say with how much truth, that a certain Municipality in one year made a profit of £18,000, but the Town Council in their wisdom decided that the Electricity department should contribute £20,000 to the Relief of Rates, with the result that the undertaking made a loss of £2,000. (Laughter). He did not think any of them would agree with a policy of that kind. It was recognised in Great Britain, America and in other countries that there should be a limit to the amount taken from any public utility undertaking for the Relief of Rates. The principle was that an undertaking should not endeavour to make as much profit as possible, but that it should render the service for which it was created at as low a price as possible. (Applause).

Mr. Councillor Coppinger (Krugersdorp) associated himself with the opposition to the decision of the Council. He did not think the Convention was aware of the implications of the motion which were that a Municipality was not to be allowed to trade at all. If there was a loss of say £5,000 on the transport department, was that to be borne by the rates, and when a profit was made on the electricity supply was it to be handed back to the consumer? He believed that any Municipality that had the interests of the people at heart would keep the cost of Electricity as low as possible, but

he did not believe that this Congress had the right to fix a maximum of 1½% on Capital Expenditure for the Relief of Rates. (Hear, hear).

The President : We are not making any such proposal. We are merely directing attention to the practice in Great Britain. We are not attempting to dictate in any way.

Mr. Councillor Coppinger : I understand the motion to say that the profits were to be limited to 1½%.

The President : No, that is quite wrong.

Mr. Allison (Mayor of Pietermaritzburg) said there were certain aspects of the matter which should be considered. Whilst having no objection to the Convention sending out a certain document the thought they would be exceeding their duty by sending it to the Administrators. This was not a matter for the Administrators until they heard from the Municipalities concerned. They had heard a lot about transport losses in other places. In Maritzburg they had up to date made a loss of £157,000 on their tramway service. Who had made that up?—the people who drove in motor cars and not the people who rode in the trams. Mr. Milton had mentioned that the Government did not offer to legislate for the Municipalities, but had only dealt with the Electricity Commission. If the Commission made a profit, what were they going to do with it? If a Municipality made a profit they had reasons for directing it to other channels. That was the position in Maritzburg, where they had Electricity and Transportation under one head. On the one hand they made a profit and on the other there was a loss, and the one counterbalanced the other. One lot of ratepayers paid too much, and others paid too little. With the Electricity Supply Commission the position was quite different, so that it was no use quoting it as an example of what should be done. The Commission was not running other services for the benefit of the people it was serving, wher?-

as the Municipalities who were making a profit out of their undertakings were in a position to spend that money upon other necessary services for the same people who contribute to the other Municipal services. When a loss was made on the Electricity Department the bill was footed out of the Rates. If in the next 20 years they made a profit, were they going to square off the other accounts? That was the whole thing. If there was a loss it must come out of revenue. Therefore it was only fair to take the profits and apply them to the other services. Last year the wattles department in Maritzburg made a profit, but this year there was a loss. How was the loss to be met? The whole financial undertaking was financed from the ordinary fund of the Municipality, therefore they could not divorce them. The best way was to limit the contribution to Revenue and have a Betterment Fund. The money for pensions and gratuities had to come out of Revenue. That had been going on for years and they must be very careful in these matters. It looked very simple but when they went into it deeply they found the difficulties. He strongly objected to the Administrators being brought into the matter.

Mr. Horrell (Pretoria) asked if they were not regarding this matter from an entirely wrong angle? We, as engineers, are merely striving to reduce the cost of electricity in order to encourage its greater use and to induce industrialists to establish their works in our towns. In this way we can reduce our working costs still further and so benefit consumers as a whole.

The President : I think there is a lot of misunderstanding regarding the decision of the Council. I will ask the Secretary to read the circular letter which was sent out.

The Secretary then read the circular letter of January 22nd, 1935, on the subject.

Mr. Metelerkamp (Bulawayo) moved that the matter be referred back to the Council for further consideration and that it be brought up again the following morning.

Mr. Horrell (Pretoria) seconded.

Mr. Councillor McLean (Port Elizabeth) said he would like to say a few words in reply to the Mayor of Maritzburg. Mr. Allison had made certain statements which showed that he had not grasped the meaning of the resolution which the Convention wished to go forward. It seemed from what Mr. Allison had told them that there was something wrong with the Electricity Department in Maritzburg when they made such a loss. If it were true that the transportation department was making a loss then the people responsible for that loss should pay for it—that was the general community. At Port Elizabeth they gave a contribution of £25,000 to the relief of rates. That left a deficit of £12,000.

Mr. Allison : That was bad management.

Mr. McLean said that was the politicians way of budgetting. They had made up that £12,000 in the half-year. The matter was becoming so serious that Councils to-day were anticipating profits from their Electricity Undertakings and creating a deficit in the department on the year's working. Municipal business should be run on business principles, and not on business methods. There was a mighty difference between the two.

If they were going to continue to take profits from certain of their business undertakings it meant that other departments would become slack.

Mr. Allison had stated that the Convention should not send forward resolutions such as that proposed but he (the speaker) could not imagine why an intelligent body like the Convention should

not make suggestions to the Councils. It was not proposed to lay down anything definite. He could see nothing in the proposal to which any reasonable Councillor should take exception.

Mr. Allison : I do not object to the resolution going forward, but to its being sent to the Administrators.

Mr. Councillor Cresswell (Ladysmith) was not in favour of the proposal being sent to the Administrators. There were such differences in this country that if they made it a National affair it would hit the smaller Municipalities very hard. Some of them had been struggling for years and the only hope they had of existing was by taking something from the Electricity profits for the Relief of Rates. If the proposal went forward to the Administrators it might bring untold trouble to a lot of Municipalities. They should be very careful in the matter.

Mr. Milton (Elec. Supply Com.) said that so far as he was aware, this matter was under the consideration of the Administrators at the moment, but that the resolution of the Convention would serve to prove to them that the Association was alive to the requirements of a really successful electricity undertaking functioning in the interests of the community concerned.

Mr. Councillor Hassett (Springs) moved that the matter be submitted to the Transvaal Municipal Congress.

The President pointed out that the matter was one affecting all the Provinces. He could not see how they could refer it to one Province only.

Mr. Councillor Cresswell (Ladysmith) thought the objects Electrical Engineers had in view would be best served by having the sympathy of their own Municipalities. As Engineers they were out for the benefit of the whole, and their purpose would best be served by not sending the resolution to the Administrators.

The resolution that a circular letter be forwarded to the Town Councils only was agreed to.

WORLD POWER CONFERENCE.

Mr. Horrell (Pretoria) who laid on the table the sub-committee report of the past year, said that it will be remembered that the matter of our contribution towards the expenses of the S.A. National Committee of the World Power Conference was discussed at our last Convention, when it was felt that it was unfair that we should be called upon to contribute £10, having regard to the nature of our membership. It was then decided to contribute £5.

The benefits accruing to our Association from the World Power Conference are perhaps a little obscure in view of our distance from the seat from the Conference. We have, however, been represented at their meetings on several occasions by Dr. van der Bijl, Mr. Swingler and others.

It had also been suggested that a sectional meeting should be held in Johannesburg next year in conjunction with the Empire Exhibition. Unfortunately it was felt that the phenomenal industrial activity in the Union at present made it impossible for Engineers and their staffs to devote the time necessary to successful organisation of such a meeting at the present time. It was hoped, however, that it would be possible to arrange for such a meeting in the near future.

It is harly necessary to detail the immense benefits which would accrue to our Engineers from the staging of such a meeting in South Africa.

The S.A. National Committee had to meet certain expenditure and until recently the Electricity Supply Commission had borne the whole cost which amounted to some £80 per annum. The Association's thanks were thus due to the Commission for their action in the past.

He felt certain they will agree with him, however, that our Association should bear its share and in view of the proposal to extend the scope of the Association he felt that we are now in a position to contribute the £10 which has been asked for. He therefore proposed that this Association contribute the sum of £10 towards the expenses of the S.A. National Committee of the World Power Conference.

Mr. Councillor McLean (Port Elizaabeth) seconded, and the motion was carried.

HOUSE SERVICE CONNECTIONS.

The President said there was one other matter to be cleared up. At last year's Convention the question of overhead connections was discussed and it was stated that the Government preferred that they should be made inside the room. He would ask Mr. Eastman to speak on this subject.

Mr. Eastman (Cape Town) mentioned that at the Salisbury Convention Mr. Clutterbuck had asked members of the Association to consider means whereby connections could be made between the outside and inside portions of the consumers' connection in such a way as to prevent accidental contact with live parts, if necessary even to the extent of making the connection inside the premises. The Cape Town Council held that it was undesirable for Municipal employees to be required to enter premises unless it was quite unavoidable, and the Electricity Department had therefore, considered ways and means of meeting Mr. Clutterbuck's wishes form the safety and also cost-of-connection standpoints. Accordingly when it came to Mr. Swingler's notice recently that "line taps" could be obtained with insulating covers a few samples were installed in exposed places and a report on what had been done was made to Mr. Clutterbuck with a view, in due course, to receiving an expression of opinion on this method of making the connection. The samples had not been in use for a long enough time

for it to be determined whether they would be entirely satisfactory in practice and there had not been sufficient time for Mr. Clutterbuck to reply to a letter written to him in this connection, but he (Mr. Eastman) had spoken to him at the Convention and understood that he was prepared to make a statement on the question. The joint could be made by this method quickly and inexpensively, and the insulated line tap, of which a sample was handed round for inspection, could be purchased in large quantities for about 5d. each.

Mr. Clutterbuck (Chief Inspector of Factories) said he could add very little to what had been stated by Mr. Eastman. At previous Conventions he had directed the attention of members to the numerous accidents caused by persons coming in contact with uninsulated conductors or portions of conductors on the roofs of buildings. Many of these occurred at the point where the service lines were joined to the house system. Mr. Swingler went into the matter and found a type of insulated connector which it was considered would be a suitable substitute for the taped joint. He has several of these connectors undergoing test in various situations in Cape Town and if these are found satisfactory it is proposed to recommend their use in cases where it is impossible to make the joint inside the roof. (Mr. Clutterbuck exhibited samples of the connector for the inspection of members).

Mr. Brown (Volksrust) asked what was the object of making the connection inside if they could make it on the roof?

The President : I believe it is the practice to make it outside the roof, but last year Mr. Clutterbuck said it should be inside.

Mr. Clutterbuck : The trouble is that in many cases, owing to defective workmanship in making the joint, a portion of the conductor is exposed.

Mr. Ralston (Dundee) said he would like to ask Mr. Clutterbuck whether the insulation of the neutral was required by the Department?

Mr. Clutterbuck : The Regulations at present definitely do not require that the neutral shall be insulated but accidents have occurred due to contact with the neutral and it is possible that the Section which exempts this conductor will be deleted when the Regulations are amended.

Mr. Eastman (Cape Town) said the joint under discussion was relatively inexpensive to make. The one submitted by Mr. Clutterbuck did not cost much—he believed it could be purchased in large quantities for 4½d. or 5d.

The President : A careless workman might involve you in an accident.

Mr. Stevens (Alice) said the cost of the work must be borne in mind. In the smaller Municipalities it was necessary to do the work as cheaply as possible. He thought the cost of the joint submitted would be cheaper than the cost of a man spending an hour on making a joint.

The President : I suggest that a number of these joints be obtained and be tried out, and then perhaps we can discuss the matter again next year.

Mr. Wright (Benoni) : Is it not a fact that the V.I.R. wire still comes out of the roof?

The President : Yes, that is so.

Street Lighting.

By H. LITTLEWOOD,
Johannesburg.

There are so many aspects of Street Lighting and each one has its own particular problem or peculiarity. Volumes have been written on this subject and it is impossible within the compass of this paper to give anything but a brief survey of the more important factors such as Engineers have to consider.

The general problems of street lighting have often been stated and will probably be familiar to you. Not everyone however, recognises how difficult a problem it is. Street Lighting is in many ways unique among the tasks undertaken by the Illuminating Engineer. Nowhere else does he meet quite so awkward a set of indeterminate factors, or quite so exacting requirements, and so little money with which to fulfil them.

On the technical side there is a host of problems. The very shape of the area to be illuminated is unusual—a long narraw strip, generally neither straight or flat. On either side are the two narrower strips of the footways, and beyond them again, in most instances, the fronts of the buildings. This area the Engineer must so light that all the various users of the highway may be able to see as they go about their particular business. His aim, above everything else, must be "accident-proof lighting." The householder must see safely the way to his door, and the policeman must be able to see to protect him. But the motorist is by far the hardest to please. He wishes to proceed down the carriageway at speeds up to say forty miles per hour, in all weather, with the certainty of seeing any obstruction in his path,

whether it be a cat or a cart. Not merely, it should be noted, an assurance that when anything is there he will see it, but a positive indication that the road ahead is clear. Unfortunately he is so placed that he views the surface of the road at glancing incidence, when perspective plays strange tricks in fore-shortening great lengths of road into a small compass, and in causing quite small areas to bulk largely in the field of view. Most disconcerting factor of all, the reflecting properties of the road surface change in a most unexpected and irresponsible fashion, playing havoc with all predictions of its appearance. Every shower of rain profoundly alters the characteristics and sometimes just when the Lighting Engineer has learned how to turn these caprices to good account, some other public authority, not under his control, resurfaces the road and his work is undone.

There are, therefore, in addition to financial and maintenance questions such technical problems as the height and the location of the light sources, distribution of intensity and of illumination and the amount of illumination necessary : problems of photometry (which in street lighting is a study in itself, particularly where large difference of colour are involved such as occur with discharge lamps) and the more nebulous problems of visibility, glare, appearance of the street, shadows and elusive dark patches—problems which are very difficult to solve quantitatively, yet which are right at the heart of street lighting.

Cost is perhaps the chief problem : if he could only spend more, it would be easy to so light streets that everyone could see with the same certainty as in daylight. This was in fact, done in certain temporary spectacular installations (during H.R.H. Prince George's visit), and is approached in the best permanent installations. Except in the most important thoroughfares such expenditure is at present out of the question, and the Lighting Engineer must needs get as many quarts as he can from a very small pint pot. His

financial problems include the proper proportioning of initial and maintenance cost, and here due regard must be paid to the reactions of the responsible Council.

The much more exacting conditions on the road brought about by the larger number of road users and the greater speed of travel necessitate a much higher standard of lighting than used to be adequate when speeds were slower and vehicles fewer.

By the lighting of streets I mean the rendering of objects in them easily visible as the motor driver or cyclist sees them when travelling. Modern street lighting on normal roads is for safety first and for psychological and æsthetic effects second. The object is to see things. You would be astonished if you realised how often this fact is forgotten and street lighting installations put up which seem to be designed with the object of making seeing difficult to the Motorist. In earlier days it was different. Lights were then put in the streets as beacons to mark the way and as a deterent to malefactors. The police still require lighting for the same purpose. I think it can be taken for granted that lighting which will give safety to cars, lorries and pedestrians will amply suffice for police supervision purposes.

May we, therefore, approach our subject from the point of view of the safety of travellers of all kinds on the road.

It will be natural to consider :—

Firstly the dangerous conditions from which street lighting must protect us.

Secondly, the factors which make for good and bad seeing, and

Thirdly, the trend of design in modern installations and roads for meeting the requirements of good seeing.

The great source of danger is, of course, that the eye is asked to function under conditions where there is so little light. Let us try to get a sense of proportion in the matter of illumination levels by reference Table 1 :—

TABLE OF ILLUMINATION.

Fig. 1.

	Foot Candles.
Sunshine	8,000.00
Ordinary Daylight	700.00
Dusk	3.00
Reasonable street illumination	0.2
Moonlight	0.02
Badly lighted street	0.01

The eye sees by contrast. (By contrast we mean actual difference in brightness or colour). If everything was of the same colour and uniformly bright we could not, even by daylight, distinguish objects from their backgrounds. There would be no contrast. We see objects ordinarily by daylight because either they are of different colours or of different brightnesses.

Now consider how our eyes react as the day closes. Before dusk comes, the daylight on an overcast day has fallen from about 700 to 100 foot candles, and seeing on the road is still reasonably good. The colours in the field of view are still strongly marked. Dusk is then upon us, and as daylight fades away the sun sets and the illumination falls over a period of 30 minutes to about 5 foot candles. At this point you find a number of cars switching on their lights, and seeing is seriously bothering us. In another 10 minutes the illumination is 2 foot candles and 60 per cent of the cars will have their lights on. At 1 foot candle, car sidelights are beginning to glare and seeing is bad. As the light falls to ½ foot candle and then to 1/10th, the contrasts which have such good discrimination in full light have grown less and less. Not only is this the case, but, furthermore, those properties of the retina which give us the sensation of colour are weakening in their action. The man who had a brown jacket and grey

trousers now appear to have clothes of a uniform dark colour. But what colour? It is hard to say, for the colour, though still there is not revealed by the eye at these low illuminations. The dark grey lorry which would be seen earlier by daylight against a somewhat lighter grey road surface now disappears, because whilst the lorry and its background are still reflecting back the same relative proportions of such small amount of light as falls on them, the dark lorry cannot become much darker, but the road surface can and does; the contrast has gone. The eye is incapable now of recognising the difference between the lorry and its background which was formerly so clear. Therefore whether due to the failure of the eye to detect difference of colour or to the absolute change in the difference of brightness of our contrasts, all contrasts diminish to the vanishing point as the light goes until, in complete darkness the eye distinguishes nothing.

The only way, therefore, to improve seeing is to do all we can to accentuate the contrasts. We must increase the brightness, either of the objects to be seen or of their background. The study of good street lighting is the study of how to make our contrasts high enough. If this seems very obvious and elementary do not on that account dismiss it. It is due to lack of thinking—or to wrong thinking—on these questions that so much of our street lighting is indifferent or bad.

This, however, is the first reason why we must increase the contrast between the objects to be seen and their background.

The planning of a street lighting installation to meet these modern requirements calls for very careful consideration, not only from the point of view of light distribution, but from the point of view of the selection of equipment.

I may, perhaps, be permitted to draw your attention to British Standard Specification No. 307 for Street Lighting. As stated in the preface of this Specification, the Specification itself is the

basis upon which street lighting installations can be designed compared, tenders invited and installations tested on an equitable basis.

The recommendations of the British Standard Specification deal with foot candle intensities, and while this method of designing installations has been the criterion in the past, you will, I think, agree that to rely purely on the foot candle intensity at a test point is not a guarantee of street lighting excellence, it is too simple a matter for a manufacturer, particularly if he happens to be in any way unscrupulous, to design a refractor that will give the necessary rating at the test point.

Had it not been for the British Standard Specification our street lighting installations would not have been of so high a standard as they are.

However, it is quite useful to lay out an installation, bearing in mind the requirements at the B.S.S. test point.

You are all familiar with the recommendations laid down in this Specification for maximum illumination and recommendations regarding spacing and mounting as indicated below :—

MAXIMUM SPACING AND ROAD-WIDTHS.

1.	2.	3.	4.	5.	6.	7.
Class.	Rated Mean Test point Illuminations (foot candles)	Minimum height of Light Source.	Maximum spacing/ Height Ratio.	Maximum Span Lengths.	Maximum Width of Road.	
					One Side Lighting.	Double Side Staggered Lighting.
A.	2-or over	30'	5	150'	45'	90'
B.	1.0	25'	6	150'	37' 6"	75'
C.	0.5	21'	8	168'	31' 6"	63'
D.	0.2	18'	9	162'	27'	54'
E.	0.1	15'	10	150'	22' 6"	45'
F.	0.05	13'	12	156'	19' 6"	39'
G.	0.02	13'	12	156'	19' 6"	39'
H.	0.01	13'	12	156'	19' 6"	39'

The design of an installation on the foot candle basis and specification of minimum intensity at test point can be regarded as the old principle, the specification based on brightness and visibility, the new principle.

Let us consider an installation on the old principle. I would go so far as to state that frequently the lighting installation bears no recognisable relation to the installation as it was planned by the Engineer.

Let us first consider the example of this effect. This slide indicates the Iso Foot candle plan of an installation on a section of a roadway determined by calculation.

Now if we endeavour to produce this in perspective the peculiar effects are apparent from the driving seat of a motor car and will be something like the next slide. If we take a photograph of the actual installation which shews surface reflection, you will see what complete havoc has been made of the installation as originally designed.

Hitherto installations have been designed on the assumption that a certain standard of illumination was the main end. If we desire to stand in the road and read a newspaper, this illumination criterion would be the right one.

Now let us consider the planning of an installation from the view points of the motorist and visibility.

It will probably be generally agreed that the requirements of an effective system of street lighting is this, that the observer should feel confident of seeing clearly any object of material size up to a considerable distance, without any discomfort due to glare. It is also generally recognised and agreed that objects are seen on a street on practically every occasion by silhouette as dark objects against a bright background and that the important matter of visibility and good ap-

pearance is therefore the brightness of the surface. We know by experience that carefully-placed sources and certain distributions of light can be made to conspire with the peculiarities of some road surfaces to produce a high brightness with a fairly even distribution, against which anything can be seen, and to keep small the dark areas in which dangers may lurk unnoticed. We know that sources ought to be fairly high, and on the outside of curves : and we have various views about central suspension.

We all know the effect on a tar macadam road on a wet night when streaks of brightness appear to run from the light source to the point of observation. Now the newer method or principle of high road brightness is to arrange these streaks in such a manner as to effectively cover the width of the carriage-way, bearing in mind that any object or objects are not thrown into contrast by virtue of being near a light source but obtain contrast from the light situated 300 to 400 feet away. One fundamental point to remember in this connection is that high mounting and close spacing is desirable (Ratio 4 to 1).

During the last two years a considerable advance has been made in the technique of light production, due to the arrival of the Electric Discharge Lamp. The physcist has given us "new lamps for old"— the Electric Discharge Lamp of greater efficiency and new characteristics. Since it happens that some of these Lamps are at the moment, best suited to street lighting, they are being developed and used for that purpose. The new lamp is not a development in street lighting but a development in lamp making.

Had the Discharge Lamps differed from the old ones only in their efficiency, it is doubtful whether many outside the technical world would have noticed the change, but it so happens that the light from the Discharge Lamps has characteristics and peculiar colours which cause immediate

comment. It is the colour more than anything else which has caught the public attention, called for criticism, and awakened interest in street lighting.

Owing to this light source being so radically and fundamentally different from that of the metal filament lamp, we have with the aid of reflecting and refracting equipment, an ideal illuminant for producing even road surface illumination.

Leading manufacturers go so far as to claim that this type of lighting is accident proof, and it is the very colour that renders it accident-proof.

As you will see from the slide the lamp is tubular in shape fitted with standard G.E.S. cap, having an overall length of 14½" and a diameter of 2⅛".

The lamp proper consists of an inner tube through which the discharge takes place. This tube contains rare gasses at a pressure of a few millimeters together with a carefully controlled quantity of mercury. This is vaporised when the discharge is taking place, and the quantity adjusted so that the voltage across the lamp terminals shall lie within closely defined limits depending on the supply voltage on which the lamp is working. The inner tube is enclosed in an outer jacket in order to keep the temperature as constant as possible.

As the name implies, the lamp owes its efficiency, due to the fact that the discharge takes place in mercury vapour under a pressure far higher than used in the tubular colour lamps. Under these changed conditions the colour of light emitted is quite different from that radiated by the blue mercury vapour type.

When analysed spectroscopically, temperature radiation gives a continuous spectrum in which the colours merge into one another without any definite boundaries, while the light from the mer-

cury tube gives a discontinuous or line spectrum in which each wavelength present is represented by a sharp defined line.

Blue, yellow and green all occur in radiation—only red is not well represented.

The first size of lamp to be made was one having a rating of 400 watts, the output of which was nearly equal to that of a 1,000 watt tungsten filament lamp.

In the construction of the high pressure mercury vapour lamp there are two emitting cathodes concealed into a cylindrical glass bulb which contains the mercury vapour and other rare gasses. Surrounding this bulb is a second glass which is evacuated.

When the lamp is running, the luminous column, which is ¼" in diameter and 6" long, does not fill the whole of the inner tube but appears stretched between the two electrodes.

It is connected to an A.C. Mains supply through a stabilising impedance. It is self striking. A choke coil is employed as an impedance as the energy loss in it can then be made extremely small.

The efficiency of the 400 Watt High Pressure Mercury Vapour Lamp (including the losses in the choke and condenser) is about 38 lumens per watt. The efficiency of the lamp alone is 40 lumens per watt. The above figures correspond to a total light output of approximately 16,000 lumens.

Te wattage of the lamp (without gear) is 400. The choke and condenser consume 20 watts, making the total wattage of the complete unit 420 with a power factor of not less than 0.83. This wattage was chosen in order that the light output from this lamp should closely approach that of a 1,000 watt tungsten fliament lamp. The life tests

on this type of lamp are such, that a manufacturer can give an average guarantee of 1,500 burning hours, although we have on record lamps approaching 3,000 hours burning.

After the lamp has been switched on, the light output increases rapidly as the temperature of the inner tube and the pressure of the mercury vapour increases. This goes on for about 3 to 4 minutes during which time the current falls. The normal operating current is 2 amps., and the initial starting current about twice this value.

If the supply fails and the lamp is switched off, it cannot be restarted for a few minutes until its temperature has fallen. After this time re-starting will take place automatically if the power supply is restarted. Later improvements have been effected and the starting time considerably reduced.

In the early lamps, what is known as a starting wire was used. This consisted of a wire connected to one of the alkaline electrodes and spiralled round the inner tube to within a short distance of the other. In this way the full potential of the supply acted across a short path in the gas and increased the ionisation produced by the primary ions.

In the later lamps a small auxilary electrode princ.ple was applied to replace the starting wire. This auxilary electrode is of high resistence, and is fitted in the foot tube close to the cap. The bottom end of the inner tube and the sealing-off pip are painted with aluminium or platinum to keep up their temperature.

From a street lighting point of view the colour of light from this lamp has often been criticised. We can, and have corrected the colour. When we add cadium and zinc to the extent of a percentage of 1.5 the effect is to reduce the efficiency of the lamp to 30 lumens per wat. We can add cadium

and zinc to enable the percentage of red to be 2.5 but again we reduce the efficiency to 30 lumens per watt. When the percentage of red is increased to 4.5 the efficiency falls to 23 lumens per wat.

I now come to, what is perhaps, the most important part of a street lighting system. You have in arranging your systems to budget for capital expenditure and also maintenance cost, and the lamp is the most important factor. The capital cost of a fitting is little or nothing compared with the cost of the lamp and the amount of electrical energy it consumes during its life.

The street lighting installation in any town usually consists of a miscellaneous collection of fittings, posts and lamps, all being mounted and spaced in a different manner. The inspecting, cleaning and re-lamping of a street lighting system is usually worked from a depot or the Municipal Power Station. In this country the lighting usually extends for some miles so that the furthest lamp on the system has got to be supplied or replaced from the depot.

In some systems of maintenance one man with helpers would be sent out to replace each burnt out lamp and, as burn outs occur evenly spread all over the system area, one days work would mean that a man with helpers might only put in 15 or 20 lamps.

It is suggested that as the best lamp manufacturers to-day, can now produce lamps regularly which differ comparatively little from one another as regards life, light output and consumption, economies could be effected and the quality of street lighting could be improved by replacing all lamps after they have burned a predetermined number of hours, that is to say from 100 to 150 hours before they are expected to fail.

This systematic replacement of lamps would have the following advantages :—

A. Failures of lamps in service would be enormously reduced. While if lamps were replaced at say, 1,000 hours the number of black-outs would be exceedingly small.

B. Each man would be able to replace considerably more lamps per day if he were transported rapidly to the area in which his days work lay, and then replaced the lamps consecutively down the various street or streets, than he can do under the system where he spends most of his day getting from one individual lamp post to another.

C. Although, at first, the number of lamps used per annum might be increased, because lamps would be removed that might still burn for another 100 hours, this loss would gradually cease as the experience gained enabled lamps of the appropriate rating to be used, provided lamps were obtained from a first class manufacturer, whose experience enabled him to produce lamps of the rating required for each different circuit.

D. In any case the small increase in the number of lamps used would be more than compensated for by the reduced layout cost of replacing lamps. (Figures supplied by various Municipalities seem to indicate that it costs about 2/6d. for getting a lamp replaced on the lighting system.

E. By dealing with replacement on this group system a much closer and simpler check can be kept on the whole street lighting system, and by means of simple monthly reports it would be possible to get attention drawn to any post or group of posts where lamp mortality was more than normal and the cause could be ascertained and removed. At the same time attention would be drawn to increased mortality over the whole system due to the inability of the fittings to withstand severe weather conditions. This control alone might easily reduce the consumption of lamps so as to more than neutralise the loss due to the removal of lamps before they were burnt out.

F. The systematic removal of lamps after they have burned, say, 1,000 hours would ensure that all lamps on the system would give a good light and would avoid the use of lamps which, due to the number of hours they had burned, were deterioating as regards candle power.

G. A further economy could be ensured by arranging for the fittings to be cleaned and overhauled at the same time as the routine replacement of lamps takes place.

You Engineers alone know the number of burn-outs that occur on your System, the number of lamps that you replace per day, and it is suggested that in the event of one man replacing 20 lamps a day in an irregular manner all over the system, he could replace at least 100 lamps per day, if it is carried out on the group replacement system.

Mention has been made of lamp failures in fittings. A common failure experienced is a water failure. When a lamp is alight and rain splashes on to it the lamp may not necessarily extinguish itself at once but when it is switched off and cools down, an action takes place inside the lamp owing to the gas filling and a very minute crack in the shape of an X takes place where the water has fallen on the lamp. When this lamp is switched on again next night it will not light owing to the fact that the bulb has become porus and air has leaked inside.

Ventilation has been claiming attention and tests carried out shew that lamp life is not seriously effected in lanterns even up to 500 or 1,000 watt size where little or no ventilation is in evidence. We have found by very careful test that a uniform heat all round the lamp and the lamp holder in an enclosed lantern has little or no effect upon reducing lamp life, but a ventilated type of lantern, especially the type employing an outer globes with a hole at the bottom indicates that lamp failures may be anticipated, due to the fact that the air stream around the lamp constantly varies. The hottest point is round the neck, and after all around the neck is the weak part of the lamp and failure will occur. Invariably one of the signs is a blackening of the bulb and the lamp collapses owing to a hot spot. You alone know your lighting requirements and draw up your specifications accordingly. Manufacturers are anxious to comply with requirements and are spending vast sums of money on research, the results of which are brought to your notice in the form of the latest developments.

It is to be expected that in the near future the old method of calling for tenders on the basis of a given quantity of street light fittings will be discarded in favour of specifications based not on British Standard Specification, but on a visibility basis.

As a guide to the newer method, the following clauses are suggested as a basis of a specification.

SUGGESTED CLAUSES.

Tenders are invited for an artificial lighting system to be installed on a main thoroughfare some — miles in length and having a width of 45 feet.

The surface of the road is tar macadam with a polished surface due to traffic.

It is proposed to prohibit the use of motor car lights when the lighting system is in operation.

The speed of the traffic will not exceed 30 miles per hour and when the lighting system is in operation, any object or objects in the road when viewed from the driver's seat of a motor car, must be visible 200 to 250 feet away.

The mounting and spacing ratio must be stated.

Candle power of lighting units to be stated on the advance and retreat side of traffic flow, together with details of the efficiency of the light source, expressed in terms of lumens per watt, and the total luminous output of the light source and fittings.

The equivalent foot candle brightness not to exceed 4 to 1.

The above clauses together with the specification of mechanical design and construction would ensure an efficient lighting system and one which would be proof against accident due to inefficient lighting.

The President thought they were all greatly indebted to Mr. Littlewood for his very interesting paper which, he felt sure, would receive a great deal of attention. (Applause).

The following contribution by **Mr. H. A. Tinson** was read by C. B. Armstrong :

At the request of Co. Ewer, Mr. Tinson while on a visit overseas has obtained some data on gaseous discharge lamps for street lighting of modern design.

Owing to Mr. Tinson's continued absence, he has asked me to present to you a short paper on the subject. However, as Mr. Littlewood has already presented a comprehensive paper on street lighting, and has also given you details of the mercury electric discharge lamp, I have arranged Mr. Tinson's paper so as to give you a brief description of the sodium electric discharge lamp which was not mentioned by Mr. Littlewood.

Contrary to what has been done in Europe, the 10,000 lumen lamp has proved to be more popular in America than the original 6,000 lumen lamp. In fact, the 6,000 lumen lamp is not now considered standard. The 10,000 lumen multiple type lamp is slightly less efficient than the series type, because individual lamp current regulation must be provided by means of a reactance transformer. The total energy required is 255 watts, showing an efficiency of slightly under 40 lumens per watt.

By way of interest it may be stated that the straight series type 10,000 lumen Sodium lamp operates at 195 watts and the series insulating individual lamp transformer type at 220 watts.

Now that these figures have been attained in the operation of lamps with a light output of 10,000 lumens it may be safely stated that really high efficiency lamps are available for commercial

use. I am told that the reflector equipment used in the design of these lamps could be made still more effective, as regards light control, but as it is very difficult to secure mounting heights of more than 20 to 25 feet, it has been found desirable to sacrifice some of the higher C.P. values obtainable in the interest of better visibility and better appearance.

The present form of Sodium lamp consists of a bulb about 16 inches long and about 3 inches in diameter. It is made of a special glass enclosing at each end a coiled filament, which serves as a cathode, and an open ended box of molybedenum, which serves as an anode. Thus the lamp has two anodes and two cathodes. Each anode is connected electrically to one side of the filament coil, so that only two conductors lead from each assembly. A Sodium resistant washer is cemented in the neck of the bulb to prevent the sodium vapour attacking the seal. A small quantity of sodium and an additional amount of neon gas are put into the bulb, the neon being used for starting.

A double-walled evacuated glass flask, about 16½ inches long and 4 inches in diameter is used to enclose the lamp. This flask is used to prevent heat loss and is indispensable to the operation of the lamp.

Most of the light emanates from the sides of the lamp bulb, so that it is usually operated in a horizontal position, although this need not necessarily be the case. The mechanical features of supporting the bulb and vacuum flask are simple, and the horizontal method of mounting, permits efficient re-direction of the light by simple reflectors or refracting plates.

The exciting current for the cathodes is about 10 amps. at 3 volts, and the arc current about 7 amps. Approximately 185 volts are required to strike the arc, after which approximately 27 volts are required to maintain it.

When the tube is cold, the application of the starting voltage strikes the arc in the neon gas contained in the tube. The lamp then glows brilliantly with the characteristic red colour of neon. Sufficient heat is soon stored up to vaporize the sodium and the lamp gradually acquires the normal orange-yellow colour of the sodium vapour arc. About 20 to 30 minutes are required to build up to maximum output of sodium light.

The equipment for operating the lamp includes a high reactance transformer, capacitor and choke for radio interference elimination, and a cathode pre-heating timer. These are so connected that the arc current flows through the lamp cathodes before reaching the anodes, thus making the arc current heat the cathodes at starting. The cathode pre-heating timer consists of a small normally-closed relay arranged with a thermostat latch to prevent the armature of the relay from closing for approximately 20 seconds, the time required for the thermostat latch to release the armature. The timer operating coil is connected across the contacts of the transformer and the thermostat latch and timer contacts are connected in series across the two points where the cathodes are fastened to the anodes. Thus, as long as the timer contacts are closed, the gap between the anodes is short circuited by the thermostat latch and timer contacts.

When the circuit is first energized the thermostat latch locks the timer armature out and keeps the contacts closed for the required length of time. However, the flow of current through the thermostat latch and contacts, which take the place of the arc temporarily, causes the heating of the thermostat latch, which eventually releases the armature, allowing the contacts to open. At this instant the open circuit e.m.f. of the reactance transformer will start the sodium lamp.

The timer operating coil remains energized during the operation of the lamp, but the thermostat latch begins to cool off as soon as the lamp

stops. Hence, if the power supply is interrupted, the timer resets and must repeat its cycle before the lamp will re-start. This insures that the cathodes will always be adequately pre-heated before the arc is struck.

With the flask method of construction the lamp only can readily be renewed, the vacuum flask being permanent unless it should be accidently broken in service.

It will be noted from the figures given above, that the Sodium lamp operates at approximately the same efficiency as the Mercury electric discharge lamp.

As a ready reference to the relative efficiencies of these new light sources and tungsten filament lamps the following may be of interest :—

	Total Watts	Overall Efficiency in Lumens per watt.
Sodium, 10,000 lumens	255	39.13
Mercury, 17,000 lumens	425	40
Tungsten filament, 17,900 lumens	1,000	17.9

In respect to the economic factors entering into the commercial application of electric discharge lamps, it is an open question at present if the subject is entirely considered upon the cost per lumen hour basis, having regard to the capital cost involved. These lamps are deemed better suited to the lighting of main highways rather than for business or residential streets. On business streets the monochromatic nature of the light sources may interfere with shop window displays, sign lighting etc., or, by contrast with the incandescent lamps employed for these purposes, may create an unfavourable impression upon a section of the public. On residential streets, at the present time, the light intensities provided in most places is of a low order, so that for economic reasons it would seem only possible to improve conditions by using larger lamps of the existing kind, in what might be termed conventional types of fittings.

Therefore, the field of application at the present time is most likely to be confined to illuminating the roads leading into and out of our towns situated on main highways. Most observers believe the monochromatic quality of electric discharge lamps affords greater sharpness of detail than is obtained with a corresponding intensity provided by tungsten filament lamps. However, it seems hardly correct to say that visual accuity is increased in reference to highway lighting because this term contemplates the distinguishing of small objects rather than large ones.

It is doubtful to what extent greater visual accuity is of value where the real object to be distinguished is a pedestrian, motor car, etc. But, by observations of many installations it is definitely considered easier to drive on roadways illuminated with electric discharge lamps, and thus it is likely a decrease in traffic accidents may be brought about by their use.

The light output size of light source, size of fitting, mounting height, spacing, and other factors in the application of lamps to roadway illumination, all have important bearings on the evaluation of any type of illuminant, and therefore the nature of the light source itself alone cannot be the determining factor.

The author has had the recent advantage of personally inspecting both Mercury and Sodium lighting installations on a large scale. In England the Mercury lamp is much to the fore although work is in progress on the Sodium lamp. In Holland and Belgium extensive installations of Sodium lamps are to be found on highways. The lighting of the Antwerp tunnel is quite impressive.

Street lighting generally in South Africa compares very favourably with towns of similar size overseas, and it is hoped we can keep in the van of progress and also do our share in assisting the development of these new light sources by encouraging their commercial application in South Africa, where they may be employed to advantage.

Mr. Muller (Krugersdorp) said that in regard to the question of replacement of lamps in blocks, he thought 90 days burning hours was correct.

Mr. Foden (East London) quite agreed with the author that systematic replacement of lamps had all the advantages he had enumerated. He would, however. point out one decided advantage of that system which the author appears to have omitted.

There was the legal position of the municipality where a road or street was normally lighted and one or two lights were out and an accident occurred between vehicles or to pedestrians from any cause. At the best any legal action drew in the municipality, which was undesirable from a publicity standpoint, and particularly so when it was alleged that the accident was due to bad lighting.

Another point he wanted to stress was in regard to satisfactory burning hours of lamps, and that was that due regard was not given in many cases regarding the suitability of design of the fitting, apart from the lamp, for the position it might occupy. As an example, inadequate protection from driving rain, and inadequate natural draining of the fitting away from the lamp, and cable inlets.

Mr. Rodwell (Johannesburg) in congratulating the author on his very able paper, thought he expressed the opinion of the majority of those present that they would have been content to have listened to Mr. Littlewood for a much longer period than the paper occupied in presenting, as the subject of street lighting had many ramifications which were of interest to municipal engineers.

Regarding lighting installations from a utility point of view and the effeciency of light flux distribution, he would remind the author that although he put forward a new scheme to obtain ideal lighting conditions, departing from the iso foot principles laid down in the B.S.I., little in-

formation was given how this was to be achieved in practice, apart from the recommendation of a high mounted fitting and a low pole height spacing ratio of 4—1.

The author would appreciate the difficulties of the engineer in charge of a public lighting scheme in his endeavour to put into practice the ideals of the designer, on account of the high capital expenditure involved, and he would go further and state that although individual fittings might be the last word in efficiency and economy in actual service an installation laid out according to modern practice and costing a great deal of money fell far short of the recommended higher rated mean intensities of the B.S.I. for good arterial lighting.

The table of illumination intensities which the author put forward gave a figure of .20 foot candles as reasonably good for street lighting, and as he (the speaker) presumed this value was a rated mean figure, he contended that to obtain this standard (which he did not doubt was highly desirable) the capital cost was excessive and would debar the Engineer in control of the lighting service of the average town in South Africa from embarking upon such a costly scheme.

If a rated mean test figure of .10 foot candles could be achieved by many engineers, the general standard of lighting to-day would have to be increased at least 400%.

It was interesting to note the attention given to street lighting by the British National Committee of the International Commission on Illumination in their preliminary unofficial report of the 9th plenary meeting held in Berlin and Karlsruhe in July of this year. The final report on this item would be looked forward to with interest. There was a general agreement on the necessity for a further study of background brightness in relation to visibility, the best means of producing it and the brightness of the road surface. It was further submitted that proposals as to the location on the road at which measure-

ments should always be taken, thereby enables international comparison of results to be readily made. It was also agreed that in the initial stages of the study, the eye of the observer should be five feet above the road surface.

Street lighting had become a subject of international importance, the main point being that by careful, scientific analysis, maximum values could be obtained with the capital expenditure available. This, in some instances, was of necessity very limited and it was in this respect that the findings of a Commission such as the one cited were of inestimable value, not only to the large undertaking, but more particularly to the undertaking where expenditure on street lighting had to be carried out on very sparing lines.

He would pass briefly over the methods of replacements that obtained in the largest cities of the world, except to state that it was necessary to zone off the area concerned into districts thereby enabling replacements to be dealt with in the most economical manner.

In Johannesburg they had something over 20,000 street lamps and the question of zoning off was already in process of completion. It was estimated that four complete replacements per annum would be necessary, thereby allocating to each lamp the useful life of 1,000 burning hours.

With the limited amount of series street lighting systems in Britain, scant attention had been given to this form of lighting by the B.S.I. It had been represented to them, however, through the South African Standards Institution, that standard specifications for this form of lighting should be included in the B.S.I. publications.

In conclusion, it might be stated that at the moment they were passing through a stage of rapid transition in the various forms of lamps that were provided. Mention might be made the gaseous discharge lamp, the coiled coil fila-

ment lamp, etc., pointing to the possibility that in the near future more efficient lighting might be obtained with a slight increase in initial capital expenditure, but showing a big saving by the increase in lumens per watt. (Applause).

Mr. Harvey (Springs) said it gave him much pleasure to be able to contribute to the discussion of Mr. Littlewood's most excellent and important paper. The problems of street lighting was a subject which deserved much greater attention than it had had in the past. He had had an opportunity of listening to and reading several papers which had been given by Mr. Littlewood, who had certainly given the subject a lot of time and energy.

Street lighting was really a financial matter, as the author said. In other words—so much to do, so little to do it with. If an Engineer came to his Council and said "I recommend this particular fitting at 35/–. "the Council as a rule would say "but why not this one at 25/–? it looks the same." They then went into the technical and intrinsic side, and after a long and simple explanation the Council would say "That is so, but is all that important—they still look the same to me." Fortunately that did not happen at Springs (laughter)

He would like the author to give them a little more information regarding his statement : "Just when the lighting Engineer has learned how to turn these caprices to good account, some other public authority not under his control resurfaces the road and his work is undone." Surely if a road was resurfaced the new surface must almost in every detail be the same as the original surface, the camber could not be altered to any mark or appreciable extent, and the colour remained the same.

He was pleased that the author touched upon the type of lighting so prominent on the Reef, that was where an attempt had been made to light up a road with tubes for poles, 8" iron enamel

shades, and 40 watt vacuum lamps. The lighting certainly acted as beacons indicating the road, but they were a beastly nuisance to motorists, and for safe driving it would be better to be without lights at all.

In connection with the British Standard specifications dealing with the intensity of lighting, it certainly had defects, and the unscrupulous manufacturer might to a certain extent try to humbug the consumer. But instead of one test point, if they called for the light distribution curves, no unscrupulous manufacturer would be able to get away with anything.

The author went on to refer to even distribution. He (the speaker) would like to know if even distribution could be obtained with the ordinary type of reflector, or lantern, without a refrator?

With reference to the present phase through which they were going with the new discharge tube or lamp, it showed that history repeated itself. The Cooper-Hewitt mercury vapour lamp when it came to the front round about 1908, was compared with other light sources.

The prinicipal advantages claimed for the Cooper-Hewitt mercury lamp were its high economy of operation, uniform distribution of light, absence of glare and deep shadows. The chief disadvantages for some purposes, while it was a distinct advantage for others, was the absence of red rays which gave the light a greenish appearance and rendered it useless where colours must be distinguished. In such light red appeared as dark purple and so the colour of which red was an element was altered.

In efficiency the mercury vapour lamp was superior to most filament lamps, its specific consumption being only .5 watts per candle power.

The superior distribution obtained with better lighting was utilised in the case of the mercury lighting lamp, in the lighting of printing presses,

steel works and machine shops, pipe mills, etc. The text book from which I am quoting then goes on to say that many attemps have been made to use a substance for the kathode that would give off all the colours in about the proportion that they existed in sunlight, but nothing better than mercury has been found.

Although the efficiency of the lamp had been decidedly improved the colour effect was still the bugbearer—if he might use the word. If the colour could be rectified then there would be nothing to touch the lamp for street lighting.

With these lamps on a long run of street lighting would it be possible to use one large choke and one condenser instead of several small units at each lamp? He would also like to know how the light output varied with the life of the lamp, particularly the lamp that had burned 3,000 hous? Also how the life and the luminous output over the life of the lamp was affected when the colour had been corrected by the use of cadium and zinc? He would also like to know how the efficiency and distribution compared with the sodium lamp?

On the chokes referred to what would be the results if the lamp were connected to a lower tap than specified, and what would be the result if it were connected on to a higher tap than that specified?

On the system of maintenance, the scheme of group changing of lamps was perfect in theory, but it would really be expensive in practice. His experience was that they could always allow 10% of the new lamps put in as short life lamps. These lamps had therefore to be changed long before the general run so that in systematic changing they would be discarding close on 10% good lamps when replacing the 10% early failures.

He would like to ask the author what percentage of total lamp failures would be put down to water failures. He assumed that water failures would be non-existent with lanterns with outer globes.

In the suggested specification, did the author consider it would be safe to prohibit the use of motor car lights in any street, as assuming a failure of supply, a failure of four lamps on adjacent poles, and if an accident occurred, would not the authority be liable because the lamps were out? (Applause).

Mr. Horrell (Pretoria) said that he had been most interested to hear Mr. Harvey's remarks and to learn that he has now adopted the new type of lamp for a portion of the street lighting in Springs. Surely this represents a complete reversal of the opinion expressed at the Salisbury Convention. It may possibly be that Mr. Harvey's condemnation of the system at that Convention influenced the Chairman of his Committee for, although they had a trial installation, they did not succeed in securing its adoption.

He would like to add his congratulations to Mr. Littlewood on the presentation of such a valuable paper.

Mr. Rodwell (Johannesburg) suggested that Pretoria should stamp their discarded lamps. If it was more efficient to have the group system, it should be adopted irrespective of whether the lamps were used again or not. They had had these lamps in Johannesburg, and they had given every satisfaction apart from the alleviation of the red ray. He believed this type of lamp had a great future before it.

Mr. Metelerkamp (Bulawayo) added his congratulations to those offered to Mr. Littlewood.

In connection with the group replacement system the economics of this system depend primarily on the initial cost of the lamp. According to the figures given by the writer, there would be a loss of 100/150 burning hours, whereas the cost of lamp replacement would be reduced by the ratio of 20 : 100, i.e., one-fifth.

It is impossible to obtain absolute constant voltage on any street lighting circuit, so that if the light voltage curve of the lamp in question is considered, there would be a greater loss of burning hours on the lamps at the far end of the circuit than those nearer the substation.

He was of the opinion that, in practice it would be difficult to justify group replacement of lamps, except perhaps in the cheaper type of low wattage vacuum lamps.

Mr. Clinton (Salisbury) thought they should obtain more co-operation from the road engineers. There were certain characteristics of a roadway which would be very difficult to obviate, but the surfacing of roads might undergo an improvement, and he would like the author to tell them whether he had any knowledge of experiments being conducted by overseas concerns in this connection.

Mr. Councillor McLean asked to be allowed, as a Councillor Member, to thank Mr. Littlewood. They had an illustration of the effect of this light in Port Elizabeth. Some dozen or so lamps were installed on the beach and because of the pea green colour the experiment was most unfortunate : one lady, in fact, rushed her husband off to a doctor (laughter). If the colour could not be corrected, he was afraid that so far as the ladies were concerned this light would never be popular (renewed laughter).

Mr. Ralston (Dundee) also congratulated the the author. In his town they were considering the question of street lighting. Did the 2/6d. mentioned by the author include the price of the lamp (laughter). Also what was the action of the lamp if the current was interrupted. It was noteworthy that the colour of the lamp went back to the days of the old arc lamp. The question of the lamp being taken out of circuit 100 hours before its completed life was a rather serious one, and did the lamp show up a black cat better than a white cat (more laughter).

Mr. Councillor Fowkes (Cape Town) said that in view of the preponderance of the technical side of the discussion, perhaps a few comments from a layman might not be out of place. He was primarily interested as a motorist and a user of our roads, and the views he expressed were those of the ordinary man in the street. He thought they all agreed that the introduction of the motor car and the resulting conditions caused by the speed and density of modern traffic on the principle thoroughfares of their cities had brought in their train entirely new problems in street lighting which would require to be dealt with, if they would make their roads reasonably safe under the conditions which now prevailed. In stating as briefly as possible a few of these problems as they appeared to him, he would like first of all to disclaim any special knowledge on the subject, and he did not wish to pose either as an expert or as an authority. He left that to those whose profession it was to deal with these matters. He thought the most important factor to be considered from the road user's point of view was safety, not only for pedestrians, but also for the motorist, and this could be summed up in the one word, "visibility." If they took the specification laid down by Mr. Littlewood that any object on the road when viewed from the driver's seat of a motor car, must be visible from 200 to 250 feet away—and he thought that was a reasonable requirement to lay down, then they must consider ways and means of bringing this about. He thought they would all accept the contention that visibility depended on contrast, either by making the object appear light against a dark background, or dark against a light background. The latter appeared to be the most feasible if not the only method they could adopt in practice.

The problem therefore appeared to resolve itself into so illuminating the road surface as to render objects visible as a dark silhouete against that light background.

Fortunately the introduction of discharge lamps had placed increased facilities in the hands of Engineers which would enable them in future to intensify the brightness of road surfaces much more easily and more effectively than had been possible in the past.

The next step was to use the light available to the utmost advantage, bearing in mind the nature of the road surface itself, and the angle at which the light was reflected to the eye of the observer. The disadvantages of tarred macadam, owing to the highly polished state it assumed, was common knowledge to all of them, and the problem of reducing the mirror-like effect particularly after rain, was one of vital importance. It might mean closer co-operation and understanding between the road engineer on the one hand, and the illumination engineer on the other, the one to provide a suitable road surface that would diffuse and reflect the largest possible amount of light over a wide area, and the other to so arrange the source of light as to give maximum results in the direction already indicated.

The spacing of light poles, the height of the lamps above the road, the precautions to prevent glare, the focussing or reflection of the light beams on to the road in the best possible manner, were matters with which he realised he was not competent to deal, but when one considered the amount of light obtainable from a motor car head lamp with small power, it did raise the question as to whether such important matters as reflection and directional lighting had received the amount of consideration they deserved in the solution of street lighting problems.

He knew they would tell him that the crux of the whole problem was one of cost. He quite agreed, and that brought him to a point that he felt sure would interest his brother Councillors.

In Cape Town the electricity department was voted a fixed sum annually for street lighting, and the actual cost to the department had for some years past exceeded this amount by some £7,000 per annum. Consequently any extensions for improved lighting of existing roads, or the normal lighting of new roads, was an increased loss to the department, and it was easy to understand that the committee was very diffident in increasing this burden. That condition of affairs did not make for progress but rather the reverse. It therefore appeared to him that the more equitable method would be to reimburse the electricity undertaking on a basis of actual cost, sufficient to cover interest and redemption on the lighting installation, maintenance and cost of current used. (Applause).

Mr. Eastman (Cape Town) said that the key point of Mr. Littlewood's paper was the importance of making objects visible on the road having particular regard to the great increase in motor traffic during recent years. Statistics relating to South Africa on this question are not available, but figures published in the Municipal Journal and Public Works Engineer (11th May, 1934) showed that about 27% of the street accidents which occurred in England took place at such times that they could have been influenced by street lighting.

There was no branch of lighting engineering in which performance lagged so far behind requirements as street lighting, and it was a matter for congratulation that the question was being investigated by the British Standards Institution from the point of view of providing better visibility as compared with the Institution's previous work in specifying illumination values. A very important point brought out in Mr. Littlewood's paper was that under certain conditions, even of good illumination, an object on the road could be quite invisible. Comparing the fact that in a photometer the dividing line between two illuminated surfaces would disappear only when the quality of the light of the sources of illumination

under test was the same with the conditions obtaining when an object on the road was illuminated by street lamps as well as by motor-car head lamps, he suggested that disappearance of the outline of the object could not occur if the street lighting units used emitted light of entirely different characteristics from the motor-car head lamps, such as, for example, monochromatic lighting units of the gaseous vapour type.

He thought it possible that the better definition of an object in a street illuminated by monochromatic sources of light when seen from behind motor-car head lamps might be due to this principle.

Mr. Littlewood's suggestion regarding the replacement of lamps did not take into account replacements which required to be made through unforseen occurrences including stone throwing. In Cape Town a large number of reflectors were purchased designed so that the lamp would project conspicuously below, and in certain areas it was found that they afforded an irresistable target for stones, air-gun pellets etc. On tests being carried out with the reflector turned upside down it was found that its effectiveness as a street lighting unit was actually somewhat improved, and since the lamp did not then project appreciably below the edge of the reflectors, losses due to the causes referred to, had been reduced very considerably.

Mr. Councillor Coppinger (Krugersdorp) said Mr. Littlewood's most interesting paper had been within the understanding of even a town councillor. He wished to ask Mr. Littlewood whether he would not consider ten foot standards instead of thirty foot ones? He realised there were certain difficulties in the way of the lateral distribution of light but he thought it possible for Engineers to secure better results in this direction with the new electric discharge lamps. Unlike his colleague from Krugersdorp, he was very fond of trees, but Mr. Muller was very fond of lamps (laughter). This resulted in a perpetual feud between them.

REPLY TO DISCUSSION.

communicated by Mr. Littlewood.

It has been to me extremely interesting to listen to the discussion and debate in connection with Street Lighting and as many of the Speakers have touched upon the same subject, I will endeavour to answer the questions collectively.

In so far as Street Lighting Fittings are concerned, very often sufficient regard is not given by a Council to the all-important question of design. Invariably it is a question of price, but as pointed out in the Paper presented to you, the price of the fitting is not of great importance when you consider that it has to envelop a lamp, and exposure of lamps invariably leads to high mortality and where practicable fittings should be of an all-enclosed or protective type.

Referring to the question of the design of lighting installations and the mounting and spacing ratio of 4 : 1, if characteristic distribution curves which are available from Manufacturers, are carefully studied, and the disposition of the lighting units arranged in such a manner as to enable the light flux to adequately overlap, then a high road brightness can result, and it is not so much a question of foot candle intensity.

Foot candle intensities between the units of a system become very misleading and we have found by experience that sacrificing foot candle intensity and arranging a more even distribution over the road surface, results in better visibility.

Criticism has been levelled at the colour of the electric discharge lamps but a street lighting installation is, after all, utility first, and æsthetic reason is a secondary consideration.

Experience has shewn that on a spacing ratio of 4 : 1 and the brightness of the road, the general intensity of illumination from such light sources rather overcome the colour effect.

It is noticeable outside the Town Hall here, the electric discharge lamps are mounted and spaced fairly close together, with the result that a good intensity of illumination is available and one or two speakers have not realised that this lighting is by means of discharge lamps. The intensity has rather overcome the colour prejudice. In any event the visibility obtained from this light source is superior to that of the tungsten filament lamp.

We have not as yet been able to perfect the means of controlling a group of these lamps from one choke or condenser.

With regard to the arrangement of the tappings on the chokes, the lamps will stand a voltage rise. If, of course, this takes place over a prolonged period, the interior cylinder of the lamp will overheat and eventually burst.

As critical voltage has improved the striking and also the maintenance and the maximum luminous output of the lamp, it is important that the tappings laid down by the manufacturer on the choke coil are adhered to.

In the early design of lamps the restarting period after the current had been cut off was considerable, but we have been able to overcome that to a certain extent when the restarting time has been cut down approximately by half.

A gradual drop in voltage does not put the lamp out. We have had no report from the Johannesburg Municipality that the time signal causes the lamps to go out.

The efficiency of the mercury discharge lamp is higher in lumens per watt than that of the sodium, being 38—40 lumens per watt.

With regard to the question of road surfaces, this matter is receiving very careful consideration and experiments and tests have been conducted overseas and are being conducted in this country with a view to ascertaining the best surface to conspire with the street lighting system.

At a later date information will no doubt be forthcoming in a comprehensive manner on this important matter.

It would appear that the most important point raised is in connection with the discarding of lamps replaced owing to premature failure. I will submit an example basing my contention upon a number of assumptions. I am of the opinion that these figures are conservative but each Engineer may, of course, correct them to suit his own individual case.

Start with 100 lamps. As indicated in the paper, the cost of replacing lamps in a haphazard manner is 2/6d. per lamp. Therefore, the cost of replacing 100 lamps is £12 10s. 0d; the average life of the lamp is 1,000 hours. Under the arrangement of group replacement, a man would have little difficulty in replacing 100 lamps per day. For the sake of argument let us reduce this figure to 50. The cost is unlikely to exceed 30/– per day, for the sake of argument say, £2. Therefore, the total cost is £4 for the 100 lamps.

To this sum, we must, however, add the value of lamp hours that we are discarding. It is suggested that lamps should be replaced after, say, 900 hours. Even then, however, a small number of replacements will have to be made due to premature failures.

Let us assume Mr. Harvey's figure of 10%.

Lamp Hours Discarded.

90 lamps will be removed after burning 900 hours, therefore, lamp hours lost $= 90 \times 100 = 9{,}000$.

Coming now to the premature failures we must make some assumption as to when these 10% failures are replaced. Let us assume after 800 hours (it is obvious that the later the replacement the greater the waste). Therefore lamp hours discarded in the case of the 10% replacement of premature of failures is 10 x 9,000 = 9,000 as these lamps have only burned 100 lamp hours. Therefore the total lamp hours discarded is therefore 18,000.

We must, however, assume a value for the lamp —let us say 2/–. Therefore the value of one lamp hour is $\frac{24}{1,000}$ therefore the value of 18,000 lamp hours is :—

$$24 \times 18d. = £1\ 16s.\ 0d.$$

We still have to make a further allowance. The 10% premature failures have to be replaced haphapard and the cost of replacement is 2/6d. per lamp. The total cost of replacement (of the 10% spares) is 25/–.

The total cost therefore of changing 100 lamps is :—

£4	0	0	
1	16	0	
1	5	0	
£7	1	0	= a saving of £5 9s. 0d.

In practice I would suggest that this saving can be increased as the basis of calculation is loaded against the group replacement system.

One appreciates the difficulty encountered in lighting thoroughfares where trees are in evidence, and sometimes central overhead suspended units meet the case (although not to be advocated).

It seems, however, in the case of Krugersdorp that ornamental units placed fairly close together and equipped with lamps that will not cause undue glare would meet the case.

Street lighting is becoming a matter of increasing importance and I urge upon you not to allow the estimates for this all important work to be reduced.

Municipalities have the welfare and safety of the Public to consider and it is not fair that human life should be jeopardised for a Municipal Budget.

High Tension Feeder Protection

with special reference to the

Pretoria Electrical Distribution System

By Messrs. D. J. HUGO, B.Sc. (Eng).,
and J. WILSON, B.Sc. (Eng).
PRETORIA.

In the absence of the authors, Mr. Horrell (Pretoria(read the following paper on "High Tension Feeder Protection" by Messrs. D. H. Hugo and J. Wilson, Pretoria :—

INTRODUCTION.

It is not without a certain amount of diffidence that the authors have accepted the invitation to present a paper on the subject of "protection" in view of the many excellent works which are already in existence on the subject.

While it is too much to expect, therefore to be able to contribute much of value in a short paper of this nature, it is nevertheless felt, that, as the subject is more often than not treated from the theoretical rather than the practical point of view, a short description of the feeder protective systems adopted for the High Tension reticulation in Pretoria and their operation under actual fault conditions will not be without interest.

THE HIGH TENSION FEEDER NETWORK.

Fig. 1 has been prepared to show diagramatically the High Tension Feeder Network which serves the various step down substations in the

City. The types and sizes of cables in use, protective system and transmission voltages are shown for each feeder.

It will be noted that two primary transmission voltages are employed, viz : 6,600 volts and 11 000 volts. The 6,600 volt system is the original one and was inaugurated in 1923 at the time of changing over from Direct to Alternating Current generation. It was soon evident, however, that with the load centre moving further and further away from the Power Station, and with the load increasing at an altogether unexpected rate, a higher transmission pressure would offer great advantages in efficiency and economy of transmission. It has been the policy, therefore, since 1929 to lay 11,000 volt feeders whenever a new feeder was required, although for some years these feeders were actually supplied at 6,600 volts. Since the commissioning of the 12,000 volt generating plant, installed at the Power Station under the 1930 extensions, these feeders distribute energy at 11,000 volts.

It will be noticed that the feeders forming the high tension network are installed on the ring system. It follows, therefore, that the automatic protection installed must be competent to disconnect the faulty section at each end without disturbing the supply to healthy sections of the network.

Pretoria has relied on one or other of the "Unit" systems of automatic feeder protection to achieve this end and the experience gained to date has not shown any necessity to turn to other methods.

At the outset all High Tension feeders installed were of the 6 core type and were protected on the Merz-Hunter Split Conductor system. This system, together with the Callender Hunter Four Core Protective System was also employed for the older 11 000 volt feeders. Both these systems employ a special form of cable and as will be seen later,

the former requires special switchgear arrangement while the latter has to be designed for the particular feeder which is to be protected.

More recently, however, a change to the Reyrolle Split Pilot system has been made so far as newly laid 11,000 volt feeders are concerned and to the Reyrolle Injector Split Conductor Protection in the case of two 11,000 volt, 6 core feeders which had been laid a year or two ago and supplied at 6,600 volts pending supply at 11,000 volts being made available. Although it has not been possible to arrive at definite figures in regard to the relative costs of the various systems, owing to the number of variable factors involved, it would appear that the Reyrolle Split Pilot System is slightly cheaper without incurring any disadvantage so far as its efficacy is concerned.

The above four systems will now be treated at greater length and where possible operating experience will be given.

THE MERZ-HUNTER SPLIT CONDUCTOR FEEDER PROTECTIVE SYSTEM.

This system provides unit protection for each feeder in the network for which it is installed. It disconnects the feeder at each end if it is faulty or keeps it in service in the event of severe straight through fault currents traversing it should it be sound.

The principle underlying this system is that of providing two parallel paths per phase within the cable, of equal impedance, in which the current divides equally provided that the insulation is sound. On the occurrence of a fault in the cable this equality of current division is impaired, and a relay, responsive to the difference of the currents in the two parallel circuits or splits trips the circuit breaker at each end of the feeder.

The system requires a cable of special construction of which three forms are available, viz : the segmental split, the concentric and the six core

pattern. The latter pattern has been adopted in Pretoria and is shown in section in Fig. II. In this type each split is symmetrically situated with respect to all the others and both capacitances and inductances of all splits are therefore the same. It has a further advantage in that the diametrical arrangement of the splits precludes the possibility of a short circuit between splits, which would render the protection inoperative.

The principle of the split conductor system of protection is shown in Fig. III. from which it will be seen that the two splits of each phase are taken in opposite directions through the cores of the current transformers at each end of the line.

The secondaries of these current transformers are connected to the relays which control the tripping supply of the circuit breakers at each end of the feeder. Consequently if the insulation of the feeder should fail, either to earth or between phases the relays will operate due to the secondary e.m.f. set up and the faulty feeder will thus be isolated from the source of supply immediately, irrespective of the direction of feed.

It will be noted from the figure that a special form of circuit breaker is employed at each end of the feeder this having two sets of contacts for each phase on the feeder side. The reason for this is that in this system of protection the value of the fault current necessary to operate the relay varies with the position of the fault. Take the case of a fault near one end of the feeder. A considerable inequality of the currents in the splits will be set up at this end causing the relay to trip the circuit breaker but if the two splits remain connected at this end the currents in them at the remote end would remain approximately equal since the impedances of the splits would be practically the same. Operation of the relay would therefore be uncertain. The use of the special circuit breaker, however, ensures separation of the two parallel paths so that only the faulty split

will carry current at the end remote from the fault and the breaker at this end will therefore be tripped immediately after the first.

The necessity of providing special circuit breakers add materially to the cost of the system but is preferable to the alternative method of employing ordinary circuit breakers in conjunction with protective current transformers having considerable primary leakage reactance, since in order to obtain sufficient reactance to produce the required difference of current in the splits the transformers must have wound primaries. Moreover, with such a system, the protective transformers have to be designed according to the characteristics of the particular feeder to be protected, whereas when the special split phase circuit breaker is employed the system is universal and can make use of bar primary type current transformers.

The fault current settings for split-conductor gear can be of the order of 30 amperes which is, incidentally, the setting employed in Pretoria. This is the setting, irrespective of the length of the feeder and implies a fault current of 30 amperes at either end of the feeder and 60 amperes at the middle. It is claimed that when using this system in conjunction with split phase circuit breakers it is stable for straight through currents up to 30,000 amperes.

The system thus provides selective protection for particular feeders, quite independently of switching operation, or fault conditions on other portions of the network. No pilot wires or cables are required and the protective gear at each end of the feeder is complete in itself, not being required to balance against other apparatus at the remote end of the feeder.

As regards experience gained in the operation of the split-conductor system, faults on feeders protected by this system have occurred on three occasions. On the first of these, the affected feeder had been in commission for some eight

years. During excavation work at a position approximately midway in the length of the feeder, a pick was driven into the cable, damaging two splits of adjacent phases. The protective gear operated immediately, isolating the faulty feeder at both ends without disturbing the remainder of the system in any way. A similar fault under approximately the same conditions occurred within a short while of the first and again the protection functioned admirably clearing the feeder at both ends.

On the third occasion the fault was again produced by picking the feeder concerned, but in this case the fault occurred adjacent to the Power Station. The circuit breaker at the Power Station end opened immediately but the circuit breaker at the remote end failed to operate so that the feeder remained under pressure until this latter breaker was tripped by hand. Actually no disturbance was felt by the remainder of the system as the fault which had occurred on one split of one phase only, burnt itself clear almost immediately. Unfortunately as the split conductor relay concerned was not provided with an indicator it was not possible to ascertain whether it had operated or not and it is therefore possible that it may actually have operated but owing to sluggishness in the operation of the circuit breaker the latter may have failed to open. Naturally, when once the fault had burnt itself clear the fact that the splits were separated by the opening of the circuit breaker at the Power Station end would mean that there would be no difference in the currents at the remote end and therefore the relay would not be energised.

Back-up protection is provided in the form of over-load relays with graded time lags, and the fact that the relay at the remote end had not operated and that no disturbance was felt on the rest of the system lends support to the view that the fault must have burnt itself clear almost instantaneously. Under the circumstances therefore it is difficult to say whether the protection did or did not fail to perform its duty.

CALLENDER HUNTER SYSTEM OF FEEDER PROTECTION.

This system which makes use of a 4 core cable for a 3 phase feeder combines the principles of Merz-Price and split-conductor protection. A sectional view of the cable is shown in Fig. IV while Fig. V. shows the connections diagrammatically.

It will be seen that one phase is split into two parallel paths and that these splits are taken in opposite directions through the core of a current transformer at each end of the feeder, while the two plain cores of the other phases and the splits are taken through the core of an unwound balancing transformer as shown.

The arrangement is such that while the feeder is sound the currents in the splits are always equal, but any kind of fault within the feeder produces a difference of the currents in the splits thus causing the relays to operate and trip the circuit breakers as in the split conductor protection. This is achieved in the following manner : The currents flowing in the plain cores induce in the closed circuit formed by the splits, voltages which are equal and opposite as long as the currents are equal. In the event of a fault on either of the plain cores, the currents through the balancing transformers become unequal thus disturbing the equality of the voltages in the closed circuit formed by split core. A current therefore circulates in this circuit giving rise to a current in the secondary windings of the split conductor current transformers and so energising the relays to trip the circuit breakers.

Therefore, for faults on the plain cores the split core is used as the pilots of a balanced voltage Merz-Price system.

In the event of a fault on either of the splits the protection operates according to the split conductor principle. It will be observed that with this system a fault occurring at one end of the feeder results in the circuit breaker opening at

this end thus leaving the fault current to feed through two parallel paths of equal impedance. The balancing transformers, however, introduce sufficient reactance in the path of the healthy split to cause sufficient difference in the two currents to operate the relay at the remote end from the fault.

This system therefore employs standard three pole circuit breakers together with a cable of the four conductor type. The split conductor current transformer and balancing transformer at each end of the feeder are accommodated in one case which is usually external to the switchgear. It is a unit system as in the case of the split conductor system and provides against all faults in the protected feeder without permitting the disturbance to spread to healthy portions of the system.

As will have been noted from Fig. I, this system is employed on only two feeders or more correctly, the two sections of one feeder. It has, however, functioned on one occasion when a surge from another part of the system led to an insulation breakdown in a joint box on the feeder close to the power station. The affected section of the feeder was immediately isolated at both ends so that the operation was entirely satisfactory.

THE REYROLLE INJECTOR SPLIT CONDUCTOR PROTECTIVE SYSTEM.

Apart from the fact that the split conductor system of feeder protection requires a special form of cable, its chief disadvantage lies in the fact that it requires the use of either non-standard circuit breakers or high-reactance current transformers, both undesirable features.

In order to overcome these objections, the injector system has been developed, in which standard circuit breakers and low reactance current transformers are used, in conjunction with a 6 core feeder cable. The system derives its name from the fact that the split circuit of a healthy phase is used to transmit an operating current which is injected by the split-conductor current

transformer of a faulty phase in this way providing a means of tripping the circuit breakers at both ends irrespective of the position of the fault along the length protected.

The connections for the "Injector" split conductor system are shown in Fig. VI, and the principle of operation is as follows :—

For an internal fault at any point in the feeder other than near the end remote from the feeding-end isolation is effected by the unbalanced currents in the split conductors as in other forms of split conductor protection. When, however, the fault occurs near the remote end, the circuit breaker at this end trips due to the reversal of the current in one split of the affected phase Now the secondary of the split conductor current transformer at the faulty end of this phase is connected to the secondaries of the split conductor transformers in the other two phases and so injects into them currents which in turn cause current to circulate in the loops formed by the splits of these two healthy phases. These circulating currents therefore operate the split conductor relays at the feeding end and so trip the circuit breaker at this end.

It will be noted that the secondaries of the split conductor current transformers are tapped to give dissimilar ratios, the object being to ensure operation under internal phase to phase faults.

It can be seen also that the relays are fitted with restraining coils which are connected to the current transformers provided for the "back-up" overload protection so providing restraint proportional to the current flowing in the protected feeder, so that under straight through fault conditions the unbalanced current required to operate the split conductor relays is increased. This permits the use of light fault settings while at the same time it offers compensation for any slight unbalance in the impedance of the splits and ensures stability under heavy straight through fault conditions.

This system has all the advantages of the older form of split conductor protection while at the same time it permits the use of standard switchgear. Its chief disadvantage lies in the fact that the design of the current transformers is dependant on the characteristics of the feeder which is to be protected and requires the employment of a certain minimum copper section in the feeder. This section might in certain cases be uneconomical unless the load to be carried is appreciable. On the basis of a 5 mile length of feeder it must have a minimum copper section of 0.25 sq. inches. For longer feeders larger copper sections are required, while for shorter feeders the section may be less. This system of protection has only just been brought into operation in Pretoria and no experience has as yet been gained with it.

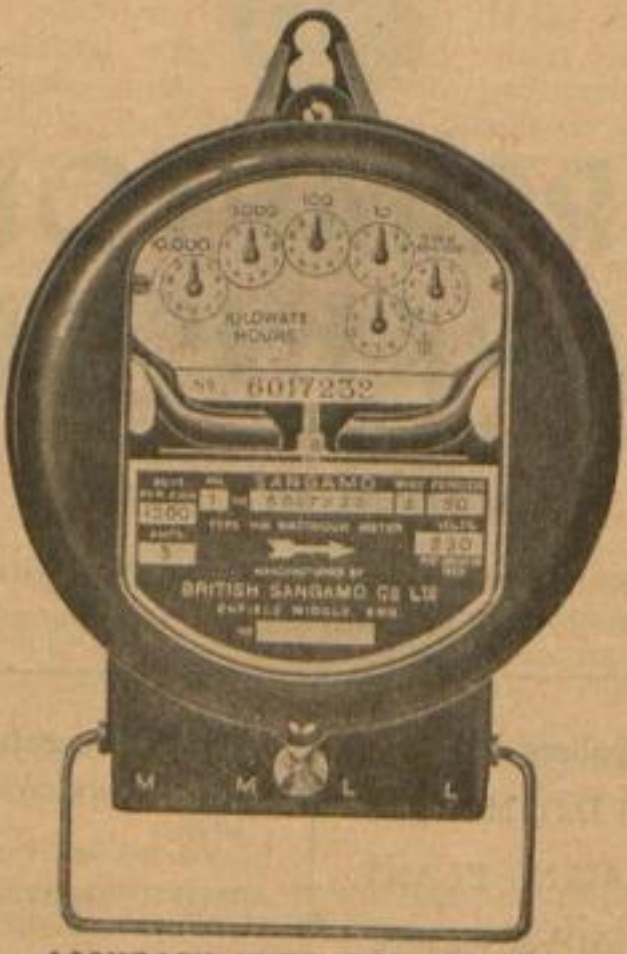
THE REYROLLE SPLIT PILOT FEEDER PROTECTIVE SYSTEM.

The father of all unit systems of feeder protection (the Merz Price System) has been subjected to many modifications since its inception in 1904, these modifications being designed to meet the altered condition consequent on improved and extended methods of transmission. The Reyrolle Split Pilot system is one of the more recent development and embodies the well-tried principles of the Merz Price, self balance and split conductor system.

The connections are shown diagrammatically in Fig. VII, from which it can be seen that the circuit breakers and feeder cable are of the standard 3 phase type, while a 3 core pilot cable is used. The latter connects together the sets of three distributed air gap transformers at each end of the protected feeder, the arrangement being such that the groups assist one another when the feeder is working under normal conditions. Since the mid-point connection is made between equipotential points on the pilots no current will flow through it under normal conditions and the current circulating in the pilots will therefore divide equally between the two parallel paths formed

British Sangamo Co., Limited.

ALL TYPES OF ELECTRICITY METERS.



ACCURACY WITH RELIABILITY.

Low Maintenance Cost.

House Service Type supplied in Bakelite Cases, thus eliminating the possibility of shock.

Used by all the leading Municipalities.

SOLE AGENTS IN SOUTH AFRICA

HUBERT DAVIES & CO., LTD.,

JOHANNESBURG.

Branches throughout South Africa.

by the split pilots. There will thus be no difference between the currents threading the cores of the differentially wound split-pilot transformers and therefore nothing to cause operation of the relays.

Under internal fault conditions, however, one set of, D. A. G. transformers will generate and carry a larger current than the other set and the difference may be regarded as an additional current superimposed upon a still inherently balanced circuit. Supposing that the right hand end is the feeding end, the D.A.G. transformers at it will evidently carry the greater current. The additional secondary current will therefore circulate via the right hand end of the common pilot 1 across the mid-point connection to the split pilot 2, and return to the right hand junction of the split pilots by the two parallel paths, viz : the short path formed by the right hand end of split pilot 2 and the longer path comprising the left hand end of the split pilot 2 and the whole of split pilot 3. Since the latter is 3 times the length of the former one quarter of the current due to the fault, will follow through it while the remaining three-fourths will use the shorter path. This is indicated in Fig. VII by the figures in the squares and by considering the directions of these currents through the split pilot transformers it is evident that half of the superimposed current is available at each end for tripping purposes.

The above discussion is obviously not accurate quantitatively since it ignores the shunting effect of the D.A.G. transformers at the left hand end. Qualitatively, however, the statement is correct, the tripping effects at both ends always being equal.

The use of D.A.G. transformers permits fairly accurate balancing of the transformers besides giving a straight line characteristic between the primary current and secondary voltage, while the method of connection adopted, known as discriminating delta, gives lower settings for earth

faults than for phase faults. Incidentally this method of connection reduces to a small value the unbalancing effects produced in the pilots by the charging current of the protected feeder thus enabling sensitive settings and high stability to be attained.

It will be noted that a small condenser shunts each split pilot transformer. Its purpose is to tune the split pilot transformer electrically so that it is responsive only to currents at normal supply frequency and so secure immunity from operation by the out-of-balance currents produced in the feeder by arcing earth faults. Such currents are of a higher frequency than the supply.

In practice the mid-point connection is made in the joint box nearest to the middle of the cable run, an adjustable resistance being inserted in the circuit, if necessary, to obtain the electrical middle point.

Using standard pilot cable usual values of the fault settings obtainable are 100 to 150 amperes for earth faults and 300 to 600 amperes for phase faults, while with such settings stability is obtained up to 8,000 amperes straight through fault current.

Thus while providing for operation under internal fault conditions, the system possesses the inherent stablity for normal and straight through fault conditions which is a necessary perquisite of modern unit protective systems.

This system was first installed in Pretoria in 1933 for the protection of the parallel feeders supplying the Iscor Steelworks.

The choice of a unit system was limited to one or other of the pilot types owing to the fact that the order for the switchgear to control the steelworks end of the supply had be placed prior to consideration being given to the matter of the systems of protection adopted in Pretoria proper

and since the Injector split conductor system employing standard circuit breakers was at that time unknown, the feeders had necessarily to be of standard type.

Shortly after the commissioning of the system and while only one feeder was alive, a surge caused an insulation failure in one of the joint boses leading in turn to a fault between two phases. The protection immediately isolated the feeder at both ends in a very satisfactory manner.

This has proved to be the only occasion to date on which the split pilot system has been called upon to operate.

As mentioned earlier in the paper, this system has now been adopted as standard for all new 11,000 volt feeders and several sections protected by this system have been placed in commission during the past few months.

CONCLUSION.

It will be noted therefore that Pretoria's experience of the "unit" systems of automatic feeder protection has been a very happy one. The departure from the Merz-Hunter Split Conductor and Callender Hunter Four Core Protective Systems must in no way be regarded as a reflection of these types of protection, but rather as a tribute to their efficacy in that the Electricity Department has been only too willing to give more recent developments of these systems a trial, especially as such developments dispense with the comparatively more expensive 6 and 4 core cable construction.

In conclusion the authors wish to express their appreciation to Mr. L. L. Horrell, the City Electrical Engineer and also their colleagues for valuable suggestions in connection with the preparation of these notes.

The President said they were indebted to Mr. Horrell for reading the paper, and their thanks were also due to the authors for the trouble they had gone to. The paper was a very valuable one for many members. (Applause).

Mr. Muller (Krugersdorp) asked how the 2 core cable compared with the 5 core cable in point of price. It would be advantageous to have two cables, as while one was under repair they could use the other.

Mr. Horrell (Pretoria) You certainly have more protection with two cables side by side.

Mr. Ralston (Dundee) asked if all the cables were laid in a common trench along with the pilot cables as he felt that in the event of a damaged cable it may have the effect upon the pilot cables thereby making the tripping gear inoperative. At Dundee they were laying high tension cable and the speaker, had made a special brick channel of sufficient depth to take the cable. A brick was placed on the top of this channel brick and the joint was made by dipping the face of the bricks in boiling tar. The speaker often wondered whether the extra cost in protecting cables was not worthy of the most serious consideration when one takes into consideration the amount of revenue lost by a shut down.

Mr. Foden (East London) congratulated the authors on their able paper, and asked the authors to say whether the Reyrolle split pilot protective system was superior to the ordinary Merz Price pilot wire protection? He had in mind the high fault necessary with the Merz Price gear to ensure that the C.B. on a sound feeder would not operate, due to a fault on an adjacent feeder. The reason for this operation was due to capacity currents induced in the pilots and therefore to overcome these capacity currents the minimum fault setting of the relay had to be considerably

increased. Was the pilot cable used with the above protective gear of the compensated type and unbalancing effect, due to capacity currents, on a healthy feeder due to a fault on another feeder diverted from the relay? Did the condenser shunts mentioned take care of the above conditions only in earth faluts where the frequency might be higher than the supply frequency? Personally he believed that the effect of these tuning condensers made the relays insensitive to the effect of straight through capacity currents—was this so? Would the authors say that the above tuned condenser gave equal or better stability than a mechanical or electrically tuned relay which only responded to the frequency of the system? (Applause).

Mr. Rodwell (Johannesburg) said he was sure that they all found the description and experience of the four systems of high tension feeder protection used in Pretoria of interest, although the methods appeared to be too expensive for small undertakings.

Although the operating experience under fault conditions obtained in Pretoria, fortunately, appeared to have been small, there could be no doubt that the four systems all satisfied the essential requirements of modern feeder protection, viz : accuracy, reliability and discrimination.

Dealing with the split pilot protective scheme adopted as standard for all new 11,000 volt feeders, he was of the opinion that there were other forms of protection available to-day which offered as complete and reliable safeguards against system faults and at the same time avoided the following disadvantages associated with the scheme under discussion :—

1. The mid-point connection with its associated adjustable resistance was a complication not required by other forms of balanced protection.

2. Three pilot wires were necessary for split pilot protection of feeders, while other systems of balanced protection required only two.

3. The circulating current flowing under normal conditions constitutes a serious objection to this form of protection because :—

(a) larger pilot wires are required. In a well-known and widely used form of balanced protection, involving the use of only two pilot wires, a pair of telephone wires are sufficient;

(b) the circulating current, whose value depends on the magnitude of the load, makes routine testing of the continuity and balance of the protective scheme difficult. In forms of protection in which there is normally no out of balance current, the healthy state of the protective arrangement is at once indicated by zero reading of a milli-ammeter inserted in series with one pilot (of a 2 pilot scheme), the continuity of the pilots being indicated at the same time by deflection between pilots.

4. The necessity for distributed air-gap and differentially wound split pilot transformers at each end, as well as ordinary current transformers at one end, at least, for overload protection and for metering purposes makes the initial cost of this scheme considerably higher than that of an arrangement using one set of ordinary current transformers at each end, which at the same time provide for overload protection and metering requirements.

5. The different ratios of the 3 current transformers at each end necessitates an increase in the number and value of spares that must be carried compared with a 2 pilot system of balanced protection using ordinary current transformers.

The authors mentioned back-up protection. It would be interesting to know the details of the overload protection and the time grading adopted in Pretoria in order to complete the picture of the protective scheme.

In conclusion it seemed to him rather unfortunate that particular systems of protection and time grading were given a variety of names. The authors, for instance, described the system of

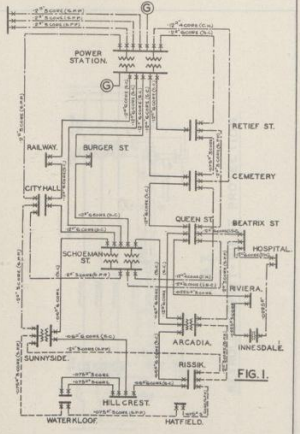


FIG. 1.

CITY COUNCIL OF PRETORIA.
ELECTRIC SUPPLY DEPT.
PROTECTION OF H.T. FEEDERS.

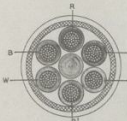


FIG. 2.
6 CORE SPLIT CONDUCTOR CABLE

FIG. 4.
CALLENDER-HUNTER
4 CORE CABLE.

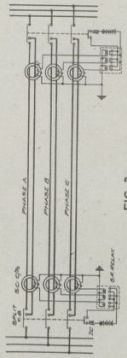


FIG. 3.
SPLIT CONDUCTOR FEEDER PROTECTION.

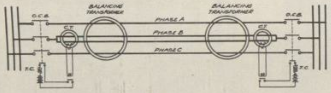


FIG. 5.

CALLENDER-HUNTER 4 CORE PROTECTIVE SYSTEM.

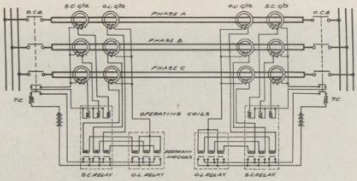


FIG. 6.

REYROLLE INJECTOR SPLIT CONDUCTOR PROTECTION.

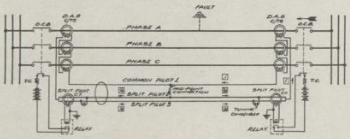


FIG. 7.

REYROLLE SPLIT-PILOT PROTECTION.

feeder protection using a 4-core cable and combining the principles of Merz Price and split conductor protection as the "Callender-Hunter System," while G. W. Stubbings, in his book on "Automatic Protection of A.C. Circuits" calls it "Merz-Hunter," and Messrs. Meares and Neale, in volume 1 of "Electrical Engineering Practice" referred to it as the "Hunter 4-core pilotless System." The numerous names for the same system of protection caused confusion and misunderstanding, and made universally adopted names highly desirable.

The authors' paper was valuable in that they had presented a subject dealing with important equipment in successful operation. (Applause).

REPLY TO DISCUSSION

(Communicated by Messrs. Hugo and Wilson).

In reply to Mr. Foden, the split pilot protective system like many others of the more modern unit types of feeder protection, was devised to overcome the limitations imposed on the ordinary Merz Price pilot wire system by the changed conditions since the latter was first developed.

A compensated pilot cable is unnecessary since the use of two of its three pilot wires on the split conductor principle ensures inherent self balancing so far as pilot capacity currents are concerned. As regards Mr. Foden's questions with reference to the small condenser shunting the windings of the split pilot transformer its purpose is to time the circuit electrically so that the relays respond only to fault current at normal frequency.

Under normal and straight through fault conditions the voltage across the tuning condenser is negligible because of the current equality in the splits. A voltage exists across its terminals only

during the period when a fault exists. The electrical tuning characteristics are such that the system is inherently stable for all frequencies which can occur above normal, including third-harmonic currents.

Mechanically tuned relays employing vibrating reeds were developed in the first instance but electrical tuning was subsequently adopted owing to the improved characteristics thereby obtained due to a smaller increase in the fault setting with decreased system frequency in the latter case.

In his discussion Mr. Rodwell contends that other forms of protection are available which offer as complete and reliable safeguards against system faults while at the same time avoiding certain disadvantages which he associated with the Split Pilot System. It is admitted that there are several other systems which, from an operating point of view, offer as good protection, but it will be appreciated that there are disadvantages associated with all systems and in making a choice, therefore, it is necessary to weigh these disadvantages against one another.

As regards the disadvantages which Mr. Rodwell enumerates, the first, viz. : that of requiring a mid-point connection is more apparent than real, since this can be arranged in the joint box nearest the middle of the cable run and when once adjusted can be forgotten.

The second, referring to the number of pilot cores, is one associated with systems other than the Split Pilot type, and can only be avoided by using other devices such as compensated cable or special arrangements in the relays. The split pilot system employs a simple, widely-used type of relay and although the principle of operation of the system may possibly appear somewhate complicated, its operation is simple and relies on well tried principles without incurring any necessity for biassing or other such arrangements.

As regards the third disadvantage, the system to which Mr. Rodwell refers is obviously of the balanced voltage type, and if the disadvantages to which such systems are exposed, as compared with a circulating current system, are to be avoided, several complications are usually necessary, and are usually more difficult to apply.

In regard to the fourth and fifth points referred to by Mr. Rodwell, the authors regret that they omitted to point out in their paper that ordinary current transformers of equal turns ratio can be employed for the split pilot system.

In this case multi-air gap summation transformers are then required between the secondaries of the line current transformers and the split pilots. In the case of Pretoria, however the method described in the paper was adopted, and the necessity of having ordinary current transformers in addition was not considered to be a serious disadvantage since separate current transformers are in any case provided for metering as it is not considered desirable to operate both protection and metering from the same set.

As regards back up protection starting from the end of the feeder most remote from the power station, the fault setting and time lag are gradually increased at each substation into which the feeder loops until the power station end is reached.

For example, taking the Power Station-City Hall-Sunnyside 11,000 volt feeder, shown in Fig. 1 of the paper, the settings are as follows :—

Sub-Station	Feeder	Fault Setting	Time Lag
Sunnyside	from City Hall	4 amps.	1.5 secs.
City Hall	to Sunnyside	5 amps.	2 secs.
do.	to Schoeman St.	7 amps.	2.5 secs.
do.	from Power Stn.	7.5 amps.	2.5 secs.
Power Station	to City Hall	7.5 amps.	3 secs.

As regards the fault settings these naturally refer to the secondary current, employing current transformers with 5 amp. secondaries.

The President : I am glad to announce that two other municipalities have joined the Association, making 35 altogether. (Applause).

The Convention then adjourned.

VISITS.

In the afternoon visits were made to the Water Purification Works of the Pietermaritzburg Municipality and to the Natal Tanning Extract Company's Factory, after which Tea was partaken of at the Botanical Gardens.

In the evening an enjoyable Cabaret was held at the Imperial Hotel.

THURSDAY, September 26th, 1935.

Some Notes on Power Station Water Problems.

By A. R. SIBSON, A.M. (S.A.)I.E.E.
Municipal Electrical Engineer, GRAAFF-REINET.

In approaching the subject embraced by the title, the writer at the outset, wishes to disclaim any suggestion that it is intended to deal exhaustively with even a tenth part of the enormous field of Water Chemistry as it affects the Power Engineer. The notes which follow refer principally to a series of investigations into feed-water and condensing water problems conducted by the writer while Assistant Electrical Engineer to the Queenstown Municipal Electrical Undertaking, and should they prove of interest to Engineers concerned with similar small plants, or provoke an interchange of views on this increasingly important subject, they will have served their purpose.

In the good old days before boiler efficiences were matched one with another in terms of decimal points, it was customary to regard boiler chemistry with tolerant amusement, and those concerned with it as mere faddists. A handful of lime now and then in the feed tank was considered beneficial and sometimes a proprietary boiler compound was resorted to, much in the way of patent medicines. For the most part the evils consequent upon faulty water were treated after they had occurred and assumed to be unfortunate but inevitable.

But now, even in the smaller towns, load factors are improving, electricity is more and more an essential service and, what is more important

tariffs are dropping for a large part nearer and nearer to the basic coal costs, making boiler efficiency and condenser efficiency all important subjects, and the modern Engineer must explore every avenue that leads to improved methods of operation.

While direct improvements in boiler efficiency, resulting from intelligent control of feed water may not be spectacular, they are nevertheless not to be ignored, while the better working conditions, and reduced repair bills are also of great importance. On the vacuum side, too, condensing conditions, dependent upon the water side of the cooling surface, are important factors in overall thermal efficiency.

It is proposed first to give a general survey of the nature of the natural waters of South Africa, then to describe the routine methods of water tests and treatment together with costs of equipment as used at Queenstown, and finally to deal with the various problems that were encountered firstly on the boiler and feed-water side, and secondly in the condensing department.

Appendices have been added giving detailed instructions for carrying out routine tests.

Rough Survey of some S.A. Waters.

Arising out of replies from a questionaire sent to a number of Municipal Steam operated schemes, some interesting facts relating to many South African Waters have been made apparent.

A rough list is given herewith, showing the more important features of the various waters from a Power Station point of view, and it will be seen at a glance that there is a marked absence of sulphates, together with almost invariably, a ponderable quantity of calcium and magnesium carbonates, as indicated by temporary hardness.

TOWN	Source of Supply	Perm. Hardness	Temp. Hardness	SO_4.	Cl.	Organic	Alkalinity
Mafeking	Underground	2.8	22.0	trace	.28	5.6	22.4
Worcester	River	nil	nil	nil	.42	.63	nil
Bulawayo	River	nil	5.52	nil	.42	—	5.04
Cradock	Underground and river	11.2	16.8	7.7	15.1	—	16.8
Ermelo	Catchment	2.16	1.37	—	—	—	1.4
Oudtshoorn	Catchment	1.05	.175	—	—	—	.175
Bloemfontein	River	nil	2.45	nil	.35	—	3.82
Kroonstad	Catchment	nil	14.7	.84	.56	—	15.0
Vryheid	River	nil	2.1	trace	.35	—	2.1
Queenstown	Catchment	nil	8.95	trace	.85	—	8.95
Grahamstown	Catchment	nil	3.5	trace	2.35	—	3.2
Graaff-Reinet	Catchment	1.4	11.2	1.61	2.52	—	9.79

All in grains per gallon.

The water supplies of the coastal belt have not been included in this rough survey, as from the little knowledge the writer has, coupled with the peculiar problems of the sea water as a condensing medium, it is certain that a set of conditions exists which are entirely different from those met inland, and with which the writer has not had personal experience.

The water supply of Worcester must surely take pride of place amongst the waters shown, as regards purity. The pH Values unfortunately, are not included as yet in the routine analyses by external chemists, but it seems likely that the water of Worcester would give a definite acid reaction.

The high chlorine content of the Cradock supply is probably due to the chlorinating plant installed there.

With the exception of Mafeking, and to a certain extent, Cradock, all the water supplies are from rivers or from catchment areas, the underground supplies from the two mentioned towns evidently producing the high alkalinities shown.

Many of the supplies show widely varying concentrations from time to time, and this is only to be expected, and lends force to the advisability of constantly watching the chemical nature of the water used.

The absence of sulphate, so frequently noticed is referred to elsewhere in these notes, and is a matter for much self congratulation. The only town having any ponderable quantity of sulphate is Cradock, where the sulphion exists principally as magnesium sulphate—probably accounting for the healthy appearances of citizens of that town. The magnesium sulphate together with the large chlorine content must, however be regarded with suspicion, the possibilities of hydrochloric acid formation in boilers being by no means remote.

On the whole, the waters of South Africa appear to be eminently suited to Power Station purposes, provided elementary care is exercised in their use, though, as this paper will show, many problems arise which no water, however pure, would prevent.

The writer regrets that owing to lack of time it has been impossible under this heading to prepare a more comprehensive survey of the waters handled by South African Engineers, but as such a survey might rightly form the basis for a separate paper, perhaps the work might be undertaken by one more fitted for the task.

Methods of Test and Treatment.

Apart from the special investigations and research work that will be described later, certain routine tests were adopted at Queenstown.

A sample analysis of the raw water used for boiler feed is as follows :—

Calcium Bi-carbonate	6.2 eq. $CaCo_3$
Magnesium Bi-carbonate	0.7 eq. $CaCo_3$
Magnesium Carbonate	1.4 eq. $CaCo_3$
Chlorides as Chlorine	0.85 grns./gal. Cl.
Sulphates	Trace
Hardness	8.3 eq. $CaCo_3$
pH Value	8.4

This was analysed every month and was found to vary according to rainfall. During periods of drought, the water, being drawn from a large reservoir, would increase in concentration of dissolved salts, suspended solids becoming less. Artificial variations were noted and found to be due, amongst other things, to experiments in gypsum treatment conducted by the Town Engineer's Department.

The standard tests on raw water consisted of : Hardness, Total Alkalinity and Phenolphthalein Alkalinity, Chlorides, Sulphates and pH Value. From these results the proportion of dissolved salts can be fairly well deduced.

Boiler water treatment was by simple lime addition, and tests of treated water were made weekly, and sometimes more frequently, these latter tests serving the double purpose of ascertaining the nature of the treatment, and ensuring efficient supervision. As Engineers will well know, it is one thing to prescribe a course of action, and quite another to see it carried out. Careful records were kept, and plotted in graph form—a typical treatment record is shown in Fig. 1. Treated water was tested for :—

Hardness. Phenolphthalein Alkalinity, Total Alkalinity.

As a rough guide to the quantity of lime needed for optimum treatment, the graph shown in Fig. 2 was drawn by conducting a series of experiments in treatment in the laboratory and plotting the results. Providing the relation between the dissolved solids remained constant, as it usually did, the results of water treatment could be compared with the graph, and it could be thereby ascertained to what extent the treatment required modifying. For the more general method of adjusting the lime charge, in the appendix will be found a formula which is useful, and for purposes of record the formula for calculating soda ash addition, where waters require this, has also been added.

The treatment consisted of adding the prescribed amount of lime, after slaking, to water contained in two 600 gallon tanks, stirring well, and allowing to stand for 24 hours. At the end of this period the water was run off from a point about one foot from the bottom into similar tanks placed immediately below, here to be stored for a similar period. This provided a total of approximately 1,000 gallons of treated water daily, which was more than enough for the make-up requirements of the station.

This system, as opposed to filtration, is remarkably simple and efficient, the tanks being drained each day of sludge after the water had

been drawn off. Best quality unslaked lime was used, slaked immediately on arrival, and mixed with a large body of water—about three gallons to a pound of lime. The mixture was kept in a closed tank, and well stirred before draining off the measured quantity, all adjustments to the lime charge being in terms of pints of mixture.

In addition to reducing the calcium and magnesium carbonates (i.e.) the so-called temporary hardness, the precipitate formed also carried down any suspended impurities, giving a clear soft make-up. The sample for test was drawn just before the water was run into the hot-well.

Boiler Drum-Water tests were also made weekly, the sample being drawn from one of the gauge glass drains, a special short copper pipe being substituted for the drain pipe when drawing the sample. About four pints were drawn, and set aside to cool. The sediment was also allowed to settle and was dried after decanting the water, being kept in dated packets for record.

Standard tests on the water were :— Hardness, Alkalinity to Phenolphthalein, Total Alkalinity, Chlorides, Sulphates and pH Value. These results were also recorded in graph form and a typical graph is seen in Fig. 3.

The quantity of Blow-down was judged from the results of this test and unnecessary waste from this source was thus avoided. The graph shown is by no means ideal, and shows too high a concentration of sodium carbonate and hydrate. This was found to be due to excessive condenser leakage, the condensing water—being Zeolite treated—was rich in sodium bi-carbonate. As a result of this indication, the trouble was traced and checked. Here again the application of tests not only gives the Engineer satisfying information about the condition of affairs in the boiler drum, but also checks the operating staff and ensures efficient supervision.

The feed-water on its way to the boiler, was tested frequently for oxygen content, and this will be referred to again a little later.

Finally, the condensing water, which was drawn from a spray cooling pond, was tested every fortnight and the concentrations noted and recorded in graph form. The tests for cooling water comprised Hardness, Total Alkalinity and Chlorides. The Chlorides being stable salts, acted as a check on the general concentration of the water. Treatment of cooling water was by Zeolite process, all the bi-carbonates of calcium and magnesium present being converted into non scale-forming sodium bi-carbonate.

The treatment plant which represented an outlay of over £400 was more than justified in practice. Condenser cleaning which had been a monthly occurrence is now done twice a year, when the soft mud is washed out. The saving on the coal bill as a result of well maintained vacuum is well over £100 per annum.

Fig. 4 shows a view of the laboratory equipment used at Queenstown. The initial outlay on this equipment was approximately £25 though the chemical balance was obtained very cheaply second-hand, this saving about £10. A detailed list of the appartus is given in the appendix. The running costs of this department were approximately £7 per annum. When it is remembered that efficient analytical supervision if obtained externally might easily cost £30 per annum, this figure will be seen to be small.

Some Problems encountered.

OIL IN CONDENSATE.

This serious occurrence is very common in small reciprocating plants, and Queenstown in the days before changing over to turbo-alternators, was no exception.

Apart from reducing boiler efficiency very considerably, the presence of oil in the lower tubes is exceedingly dangerous—especially when the boiler is being steamed in the vicinity of its maximum rating. Row after row of bottom tubes was replaced due to serious bulging caused by oil. The station was equipped with a coke and wood-wool filter in the condensate line, and a pressure filter in the feed line, and while quantities of oil were held up at both these points, the bulk passed through to the boiler.

Oil in condensate is present in two forms : firstly in ordinary suspension, and secondly in the form of an emulsion. The latter will pass the finest filter, and further, remains indefinitely in its emulsified form, thus resisting any treatment depending upon relative densities. The quantity of oil present was ascertained by viewing a sample of the condensate vertically in a test tube, and fairly accurate comparisons were possible in this way.

The problem was first approached at its origin, and the oil feed to the engines considerably reduced—this was frequently unnecessarily rapid. While improvement was noted, this, of course, did not touch the heart of the matter.

A number of experiments with filtering mediums were tried, but produced no difference whatever. The action of the filter in the condensate line, which consisted of tanks with four or five passes, depended chiefly upon the gravitational separation of the suspended oil and would have been equally effective with no filtering medium at all.

Experiments with chemical co-agulation were being conducted when the station changed over to turbines, and the oil problem ceased to be of any importance.

Subsequently at Graaff-Reinet the writer has had experience with a Lassen-Hjort oil eliminator using the chemical co-agulation system with wood-

wool filters, and this has proved to be capable of removing all traces of oil from the condensate.

The running cost of the plant at Graaff-Reinet is approximately 1.06d. per 10,000 lbs. of condensate treated. The system uses caustic soda and alumina ferric, and with reasonable supervision, there is no danger of either reagent concentrating excessively. Here again, however, it is imperative that regular tests be taken both of the treated condensate and of the boiler drum water.

The quantities of the separate reagents found to be most efficient are as follows :—

Ordinary commercial Alumina Ferric at 1.2d. per lb. Approximately .22 lb. per 10,000 lbs. Condensate treated.

Commercial caustic soda at 3.2d. per lb. Approximately .25 lb. per 10,000 lbs. Condensate treated.

The action which takes place between these two reagents is as follows :—

$$Al_2(SO_4)_3 + 6NaOH \rightarrow Al_2(OH)_6 + 3Na_2So_4.$$

The Aluminium Hydrate in forming entangles the minutest particles of oil which are brought down in the flocculent mass and are easily filtered out. The residual sodium sulphate passes through to the Boiler Drum where it is not only harmless but actually beneficial in inhibiting any tendency to caustic embrittlement.

Preparations were being made at Queenstown to test out the electrical method of co-agulation in which large direct currents are passed between electrodes through the condensate, but this was never actually tried, so the writer cannot speak from first hand experience of this system. Similarly, the centrifugal separation system was not tried—indeed it is doubtful whether the emulsified state of the bulk of the oil is amenable to this form of treatment.

SCALE FORMATION.

Scale in boiler tubes was never really a problem at Queenstown. As can be seen from the analysis of the raw water already given, calcium sulphate is conspicously absent, the only scale-forming salts present being calcium and magnesium bi-carbonates. In the water tube type of boiler, these are deposited as carbonates almost as soon as the feed water enters the drum as a result of the half-bound carbon dioxide being driven off by boiling, and the deposit to a large extent remains in the drum, a certain quantity being carried by the circulation down the back headers to the mud drum. It was customary, on opening up a boiler to find no trace of scale in the tubes, but a powdery deposit about $\frac{1}{8}$ inch thick in the drum. This on analysis proved to be largely calcium or magnesium carbonate. The lime-treatment of the make-up water did. of course reduce the quantity of bi-carbonates available for precipitation, but, as is well known, this treatment does not entirely remove the scale-forming salts.

Both calcium and to a greater extent magnesium carbonates are sparingly soluble, but fortunately the solubility increases with temperature, and therefore the deposition of these salts from solution due to saturation takes place in the cooler parts of the boiler. Very much the reverse in the case with calcium sulphate which produces a much harder and more obnoxious scale, in greatest quantities where the temperature is highest. Its removal, where present is, of course, affected by treatment with Soda Ash.

The writer has noted this peculiar—and very fortunate—absence of calcium sulphate from the natural waters of a number of towns in the north, east and midlands of the Cape Province. Other areas are not so fortunate, as reference to the general survey of South African waters will show.

BOILER CORROSION.

It is in connection with this dread enemy—corrosion, that the most interesting research work was done at Queenstown. After the change

to turbines had taken place it began to be evident that the oil trouble had in reality been a blessing in disguise. The enthusiasm over the spotless tube and drum surfaces was short-lived, for presently pit marks began to appear, the blow-down discharge assumed a rusty appearance and it was all too evident that serious corrosion was taking place, corrosion which had hitherto been prevented by a protective coating of oil.

Tests of boiler drum water indicated that the pH Value was well up, showing high alkalinity, and thus simple addition of sodium carbonate or similar alkali was clearly futile. A typical analysis of boiler drum water while trouble from corrosion was at its height, is as follows :—

Hardness	0.2 (eq. Ca Co_3)
Alkalinity to Phenolphthalein	6.0 (eq. Ca Co_3)
Alkalinity to Methyl Orange	11.5 (eq. Ca Co_3)
pH Value	11.0
Chlorine as Chlorides	8.6
Sulphion as Sulphates	2.98

All in grains per gallon.

The problem was first approached on the assumption that the carbon dioxide given off by release from the bi-carbonates was participating largely in the action in accordance with the carbonic acid theory of corrosion. This was counteracted by deliberately over-treating the make-up with lime. A definite improvement was at once noticed, the blow-down assumed normal colour and corrosion seemed to have been checked. This was followed almost immediately by severe priming and foaming, causing superheaters to become rapidly fouled with scale.

In explanation of this, later experiments showed that the tendency to foaming was greatly increased when large quantities of suspended solids were present, and it is probable also, in view of later research, that the inhibition of corrosion mentioned was due rather to a protective coating of powdery deposit, than absorption of any carbon dioxide that might have been present.

The boiler drum, headers and all tubes were then carefully painted with a graphite paint in an effort to form a protective coating. This appeared to be reasonably effective as long as the protective coating remained intact, but pit marks still made their appearance, sometimes apparently underneath the paint, in all probability due to the paint not having adhered so closely at these points.

An experiment was conducted with two pieces of boiler tube steel, one polished clean, and the other painted and polished up exactly as in the boiler. These pieces which were about 3" long and 1" wide, were immersed in a weak solution of sodium chloride, and the potential difference between them measured. It was possible to obtain about .1 volt between these electrodes. Thus it was clear that the painted surface and any part inadvertently left unpainted or imperfectly painted, would act as dissimilar metals in an electrolyte, and any tendency to electrolysis would be increased and not prevented by a graphite coating, unless such coating be uniformily perfect over the whole internal surface. The test was repeated with two identical pieces of steel, and the writer was surprised to find a slight difference of potential still indicated.

This was found to be greater with certain samples than others, and the only conclusion was that different areas of the same metal had different percentages of impurities or other alloyed substances thus producing the effect of dissimilar metals.

Vegetable colloidal compounds were next tried, the vendors of which claimed that a filmy coating on all metal work reached by the water was created. The first such compound tried proved to be of no value whatsoever—its only slight claim to touching the corrosion problem being its high alkalinity, for on analysis it proved to be no other than the inevitable soda ash hashed up in a new form; with no traces of any colloidal properties.

It should be stressed here that it is not sufficient, as is often claimed, merely to increase the pH Value of the drum water to inhibit corrosion. Corrosion of the type met with at Queenstown takes place no matter how high the pH Value or alkalinity of the water may be.

The second compound tried was analysed first and found to be almost entirely organic. Shortly after commencing treatment signs of corrosion commenced to disappear, and after careful scrutiny it was shown that by this means, at any rate, the problem could be solved. Unfortunately the cost of this latter compound was rather high, and the annual costs would have worked out at about £100 per annum or nearly 6d. per 10,000 lbs. condensate.

It should be noted, however, that successful as this treatment was in the boiler, it was unlikely to be of any value in protecting the tube surfaces of the economizer and feed piping, since the solution on its way to the boiler was extremely weak, only producing its effect by cumulative concentration in the drum.

Attempts were then made to lower the oxygen content of the feed to the boilers. At that time the delivery of the condensate pump poured in a delightful and air-enveloping cascade into the hot-well. This was altered in accordance with the diagram shown in Fig. 5, and the oxygen content which had averaged 2.7 c.c. per litre dropped to an average of 1.2 c.c. per litre. In the diagram it will be seen the bulk of the condensate from the condenser flows straight to the feed-pumps, the connection to the hot-well merely providing the water needed to cover discrepancies in the water handled by the two pumps.

While the above improvement was observed, there was still far too much oxygen present, and no lessening in rate of corrosion was noticed. It seems that in practice differences between condensate output and feed requirements are more

marked than would be supposed, and the air-impregnated water from the hot-well was constantly being drawn in.

At this stage it was suggested to the writer that the corrosion was being caused by the presence of biological organisms, and much interesting, though, as was shown later, futile work was done in the laboratory in hunting for the Crenothrix Polyspora and allied organisms. In the economizer particularly, where large nodular growths were found to grow thickly, this miscreant was hunted. The presence of the organism was eventually definitely established, but was shown to be merely incidental and not the prime cause of the corrosion.

The nature of the corrosion was ultimately demonstrated by an interesting test :—

A boiler was opened up with the drum still one-third full of water. A sample of the drum water was analysed and gave the following result :—

Hardness :—	3.0 gns./gal. eq. Ca Co_3
Total Alkalinity :—	4.5 gns./gal. eq. Ca Co_3
Chlorides as Chlorine :—	0.95 gns./gal.
pH Value :—	9.4
Sulphates :—	trace.

The water was then run out very slowly, and as the level dropped the usual rust nodules became visible—under each of which, it was known, a pit mark would be found. One of these nodules was carefully taken away, and mixed with a test-tube of distilled water. The pH Value of the water before the addition of the nodule was 6.5, but on mixing it dropped to less than 4.2 being beyond the range of the colorometric standards. A similar nodule was then analysed and gave the following result :—

Insoluble substance (Chiefly Fe $(OH)_3$) :—	98.3 parts.
Ferric Chloride :—	1.01 „
Ferric Sulphate :—	0.312 „
Moisture and undetermined :—	0.378 „
	100.000

Acidity (in terms of Ca Co_3) to the extent of 0.34 parts per 100.

This concentration of strongly acidic solutions in various spots in a drum where the water generally was strongly alkaline could only point to one thing, namely electrolysis—a solution that had been foreshadowed by the earlier experiments with graphite paint.

It was well-known, of course, that electrolysis could be combatted to a certain extent by suspending zinc plates inside the drum, and arrangements were made forthwith to carry this out. The writer was not satisfied, however, that this would be effectual: the drum itself would obviously be protected since the steel would naturally be electronegative to the zinc, and the latter only would be dissolved. But in the lower tubes, where serious and disturbing pitting had been taking place, differences in potential between different areas in the metal surfaces would be bound to produce local electrolysis, being too remote from the zinc to be swamped by its superior electrolytic action.

At the same time, the trouble was not confined to the boilers but extended to the feed-piping and the economizer as well. In the economizer, for example, it was ascertained by test that wastage, equivalent to .15 m.m. per annum throughout the surface, was taking place with, of course, much greater wastage at points where corrosion was concentrated, some of the deeper pit marks noted at the time, being almost 5 m.m. deep. The masses of highly magnetic sludge that were removed each time internal cleaning was done too, spoke eloquently of the corrosive attack that was taking place.

Perhaps a short digression into the modern theories of corrosion might not be out of place at this stage.

Water has a tendency to dissolve all substances with which it is in contact, the action depending upon the solution tension of the substance. This solution is effected by the dissociation of the

water into the H and OH ions. The OH enters into combination with the iron giving $Fe(OH)_2$ the H being plated out on the surface, eventually producing a film preventing any further solution.

If, however, dissolved oxygen is present, the Hydrogen being in its nascent form very readily combines to form H_2O the metal surface being left free for further solution. The same effect is observed in a primary cell where it is called polarisation, and the large quantities of oxygen necessary to effect depolarisation are supplied usually by manganese dioxide. It has not yet been definitely established whether the presence of an acid is necessary for this solution to take place, but even in strongly alkaline solutions—as has been shown—it is possible for isolated pockets of acid to form, produced by electrolytic action.

Now Evans has shown that two pieces of identical metal act as dissimilar metals in an electrolyte if the one is surrounded by water aerated to a greater extent than the other. Thus there are at least three possible sources of electrolysis, namely: uneven coating of graphite paint, variations in metal itself and differential aeration.

As soon as a flow of current has been established, the liquid in the near proximity of the anodic areas is dissociated, acid being formed. The Queenstown experiments showed that both the sodium chloride and sodium sulphate present in the drum were split up together with the water, the chlorine and sulphion taking the hydrogen of the water, and the sodium taking the hydroxyl ion.

$$H_2O\ (H+OH) + NaCl > NaOH + HCl$$

The tendency of the sodium hydrate would be to emigrate to cathodic areas, the hydrochloric acid being free to wreak its will.

As a result of the attack on the iron Ferric chloride is produced and this, where it comes into contact with the alkaline hydrates of the normal drum water forms the precipitate ferric hydrate, and this insoluble substance accumulates round the anodic spots giving the characteristic nodules, which act as pockets for the acids formed, and help to keep them concentrated.

It should be noted that whether the electrolysis is due in the first instance to differential aeration, or to one of the other causes; for corrosion to take place, the presence of dissolved oxygen is essential, the oxidation of the protective hydrogen film being necessary before corrosion can proceed.

Thus the problem of de-aeration was again tackled in earnest as being the one system which would at once provide equal protection to all the iron surfaces involved.

This time, a system was evolved for which the writer has just taken out provisional patents. While, of course, a proper de-aerator could be purchased and installed, this was a costly business and it was felt that with some modification the system described earlier in this paper might be made more effective.

It is universally admitted that provided the oxygen content of the feed-water can be kept in the region of 0.1 c.c. per litre, or lower, corrosion will be much reduced. Now repeated tests in the quantity of dissolved oxygen in the condensate showed that it rarely, if ever, exceeded that figure, and was in fact, usually below that amount. Thus, if it could be arranged that the output of the condensate pump was always in excess of the requirements of the feed-pump the problem of supplying the boiler with de-aerated water would be solved.

Fig. 6 gives a diagram of the system eventually designed and erected at the Queenstown station. The small pipe A carried water from the hot-well back to the condenser, passing the control valve B

on its way, this latter valve was actually a Cope's regulating valve borrowed from one of the boilers. The size of the pipe A was such that under the conditions of pressure head available, the flow of water could never be such as would flood the condenser.

The de-aerated water pumped out by the condensate pump passed along pipe C, the major portion being taken by the feed pump, and the small balance passing through to the hot-well. On its way, however, it had to pass through the orifice, thus producing a difference of head across the orifice, depending upon the quantity of the excess water. This difference of head, transferred to two vertical tanks, operated the displacement vessels E and F, the motion of which altered the position of the regulator valve.

The regulator valve was arranged to be fully open when the displacement vessels were just level (i.e.) when no water was passing through the orifice, and in this position the quantity of water passing through pipe A was sufficient to supply all but the most exceptional discrepancies between supply and demand. The excess water in passing through D caused the vessel E to rise a few inches, thereby restricting the flow through the regulator valve, which took up an intermediate position. By designing the orifice and making adjustments to the travel of the regulator valve it was possible to provide always a slight excess of condensate over boiler feed.

The apparatus was comparatively simple to install and very little alteration to existing feed-pipe arrangements was made. Valves were included—omitted for sake of clarity from the drawing in Fig. 5—which enabled the feed-system to be put back to normal in a moment.

Very careful tests of operation were then made, some tests being deliberately taken during periods when low boiler water demanded excessive feed. The result of these tests is shown in the graph

given in Fig. 7, which is typical and consists of tests of oxygen content of samples of feed water drawn from the outlet side of the economizer for two consecutive weeks. During the first week the feed system was arranged in the semi-enclosed manner, as described earlier in this paper; and during the second week, the automatic byepass was in operation.

It can be justly claimed that this system of deaeration is simple in its principle, costs nothing to run and is easily and cheaply installed alike to new or existing feed-systems.

Unfortunately, due to relinquishing the appointment at Queenstown, the writer was unable to pursue the matter further, and find out to what extent corrosion in the boilers and elsewhere was affected.

In the course of experiments with this plant, an important practical point was observed, namely that leakage of air into the feed-system via the suction side gland of the centrifugal feed-pump was a possibility not to be ignored, and it was necessary to keep this gland in good condition.

An additional method of oxygen reduction was incorporated in combination with the system described in that the old oil pressure filter in the feed-delivery line was turned into a deactivator by filling the space with steel turnings.

This makeshift arrangement produced surprisingly good results : when running without the automatic byepass, a reduction in oxygen content of from .97 to .49 was observed across the inlet and outlet of the deactivator; unfortunately no test figures are available of the final oxygen content when using both systems combined.

While it has been stated that high pH Value does not necessarily prevent corrosion, the hydrogen ion concentration does, of course, play a considerable part in determining the rate at which

corrosion will take place. In fact the number of factors that do enter into the question is legion, though in boiler plants where waters of high alkalinity are in use, the principal controls in the order of importance would be :—

Oxygen concentration.
Hydrogen ion concentration (pH Value).
Protective coatings.

In the type of plant just described, an amount of .1 c.c. of oxygen per litre is present and the corrosion is greatly reduced.

The hydrogen ion concentration then becomes, by comparison, of greater importance, and so, in addition to controlling the oxygen content, the pH Value should be kept in excess of 9. This is particularly so, in view of the fact that at higher hydrogen ion concentration (i.e. lower pH Values) the tendency for the hydrogen to form a protective film is reduced, the gas being evolved instead in the form of bubbles.

Condensing Water Problems.

For the first few years of the Reciprocating Engine regime the regular nightmare of scaled condenser tubes was faced.

The cooling water at Queenstown was drawn from a spray cooling pond, the make-up being direct from town mains through a ball-valve. When it is remembered that under full-load conditions the evaporation is likely to reach 2½ per cent. of the water circulated, and that the quantity circulated per hour is about half the total capacity of the pond, the potency of this chemical concentration plant will be realised.

Roughly the concentration of dissolved salts, if it were not for losses through windage and other leakage, and the removal and deposition of scale-forming salts in the tubes of the condenser, would

double itself in 80 hours of full-load running, and increase in proportionate arithmetical progression thereafter.

The curve shown in Fig. 8 gives the actual concentration as observed in practice over a prolonged period. Windage and other leakages were deliberately permitted to reduce the rate of concentration and the fact that for the bulk of the time the plant was running at reduced load factor also reduced evaporation below the figure stated above.

But even a comparatively small quantity of scale-forming salts, particularly the bi-carbonates of calcium and magnesium, can very quickly form a considerable coating of scale in the condenser tubes. Particularly is this so when the condenser is working near its full capacity and the outlet temperature of the cooling water high.

Precipitation of scale-forming salts in a condenser is almost entirely due to the driving off of carbon dioxide from solution, reducing the acid carbonates of lime and magnesium to the insoluble carbonates, viz. :—

$$Ca\,H_2\,(Co_3)_2 > Ca\,Co_3 + H_2O + CO_2$$

but unless the temperature rises sufficiently, the CO_2 will not be so driven off, and scale formation will be retarded.

Thus, two valuable hints in condenser working emerge, where waters similar to those encountered in the plant in question are in use. Firstly, keep the concentration in the cooling pond down as much as possible by frequent tappings of cooling water, making up again with raw water. The level can be dropped, say, to the lowest safe working level once a month, or even more frequently, making up to full capacity again. In connection with this, too, it is important to see that the level while running between times is

always maintained, since it takes but a short time for evaporation to halve the quantity of water, thereby doubling what is already a high concentration.

The second point is that a high outlet temperature should be avoided as far as possible. It is sometimes regarded as an economy to throttle the circulating pump for various diverse reasons. In doing so this question of high outlet temperatures should be taken into consideration. In the writer's opinion, the fullest use should be made of available pumping power, where danger from scaling exists.

The only real and lasting solution, however, where waters containing these scale-forming salts are in use, is water treatment. The simple lime treatment can be, and frequently is, applied here, although, as has already been pointed out, with this method, the salts in question cannot be entirely eliminated, partly because calcium and magnesium bi-carbonates even when bereft of their carbon dioxide are still slightly soluble and will deposit on concentration, but chiefly because the action will not go beyond a certain stage and the minimum residual bi-carbonates that can satisfactorily be obtained in practice is about 3 grains per gallon equivalent calcium carbonate. Even this quantity will rapidly concentrate and cause scale trouble if no other steps are taken.

It has consequently been suggested by the writer that instead of lime-treating the raw make-up, quantities of the cooling pond water itself should be tapped off regularly for treatment, thereafter being returned to the pond. A tank could be quite easily arranged, its size depending upon the size of the cooling pond, to be filled and treated daily, a small pump being used, the water being run back to the pond after about 20 hours settlement.

But the only type of treatment which finally and definitely deals with the problem is the Zeolite process. There is no time here to discuss the

mechanism of this interesting reaction; suffice it that through this means, an exchange of bases takes place, sodium being replaced for all others—thus all scale-forming salts are entirely removed, the action carrying on right to finality so that no matter what concentration takes place, none of these salts will be present.

The installation of such a plant and the benefits accruing thereby have already been referred to. The running costs, which consist of the purchase of commercial salt, work out at about 1d. per 1 000 gallons of water treated, but this figure will depend entirely upon the quantity of dissolved salts present in the water, the above figure being for raw water at Queenstown, analysis of which has already been given.

It is diffciult to assess the exact saving which was effected since so many variables are involved, but a rough idea can be gained from the fact that after installing the plant, and prior to the change-over to turbines, the coal consumption taken over twelve months reached the figure of 3.014 lbs. per unit generated, which is believed to be the lowest in the Union for reciprocating steam plant.

The direct saving due to reduced cleaning costs and improved coal consumption on days on which the condenser would otherwise be out of commission through cleaning, alone was approximately £35 per annum.

Some trouble was experienced at the outset when the new cooling pond was started up. The regular routine tests showed that in spite of the Zeolite treated make-up water, the cooling pond water was slowly increasing in hardness due to the pressure of calcium bi-carbonate. The cause of this was searched for, for quite a time, and the matter was giving some consternation until it was discovered that the outlet of water from the water cooled-bearings on the induced draught fans was trickling into the cooling pond, and, being ordinary tap water, was adding its small but im-

portant quota of untreated calcium bi-carbonate to the total. Here again the routine test methods proved their worth, as this might well have gone unobserved for some considerable time, the Zeolite process being condemned as ineffective when scale was still discovered on the tubes.

Before leaving this matter and bringing this paper to a close, it might be as well to refer to the possibilities of corrosion in condenser tubes.

It has been known for some time that waters of high alkalinity have a tendency to dissolve zinc. A pH Value of 9.5 has been suggested as the maximum allowable unless this danger is to be courted.

While no signs of such solution had so far been detected in the condensers at Queenstown the possibility was admitted, and it was clear that the building up of a strong solution of sodium bi-carbonate might possibly tend to embrittle the condenser tubes through dissolving the zinc from the alloy.

There are at least two ways in which this could be tackled. Firstly, judicious acid treatment of the cooling water converting a portion of the sodium alkali into, say sodium sulphate—this, of course, would be quite a costly method of treatment, but would certainly be effective. Secondly, the arrangement of electrodes in the water boxes of the condensers insulated from their supports but energised as one pole, the other pole being the body of the condenser, including the tubes, from a strong D.C. supply. This, by electrolytic action, would sacrifice the inserted electrodes and save the rest of the condenser.

A further warning in connection with Zeolite treated water, though rightly coming under the heading of Boiler Water problems, might perhaps be included here.

Owing to the peculiarity of many South African waters already referred to viz., the absence of sulphates, water treated by the Zeolite process contains a preponderance of sodium bi-carbonate and little or no sodium sulphate.

It has been shown conclusively by many workers that water of this nature has a dangerous tendency to bring about the condition known as caustic embrittlement. Under boiler conditions of temperature and pressure the sodium bi-carbonate is soon hydrolised to caustic soda, and in the absence of sodium sulphate, which acts as an inhibiter of the effect, embrittlement of the boiler steel is likely to proceed.

On this account Zeolite treated water was never used as a boiler make-up and a rigid watch was kept on condenser tube leakages, which had they been neglected, might have permitted dangerous concentrations of caustic soda in the boilers.

Preparations were being made, however, but were never actually carried out, for using Zeolite treated water combined with sulphuric acid treatment for boiler feed. Provided careful supervision over the use of the acid is maintained, this would have been an ideal system, giving a boiler feed with no scale forming salts whatever, and a ratio of sodium carbonate to sodium sulphate continuously adjustable at will. A certain quantity of sodium carbonate would have been retained to give the required pH Value to assist in dealing with corrosion, practically the only other salt left being the beneficial sodium sulphate.

But pending the effective solution of the de-aeration problem, it was deemed advisable to delay experimenting with Zeolite water and retain what small protection there was available from the deposits of soft scale from the lime-treated make-up.

The writer is indebted to Mr. T. P. Ashley, the Chief Electrical Engineer of the Queenstown Undertaking, for permission to publish the notes that have formed the basis of this paper, and takes this opportunity also of thanking the Association of Municipal Electrical Engineers, for the occasion provided, and for listening with patience to so young a member.

FIG. 1

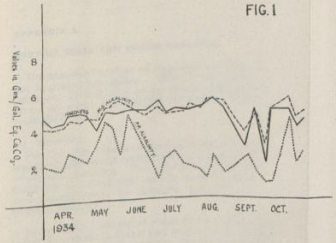


FIG. 2.

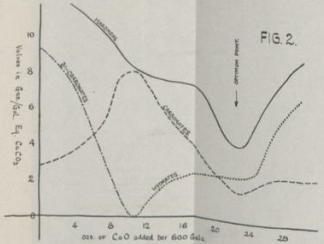
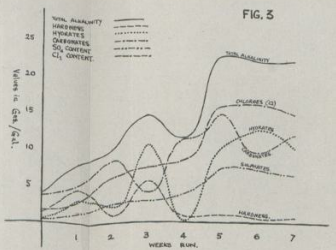


FIG. 3



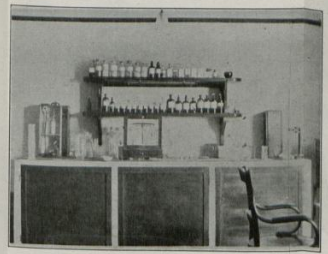


FIG. 5.

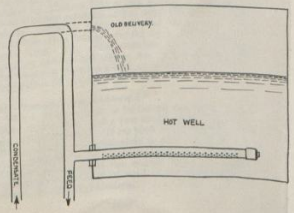


FIG. 6

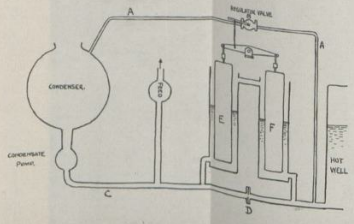


FIG. 7.

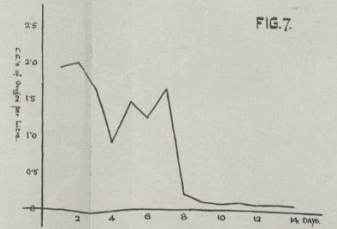
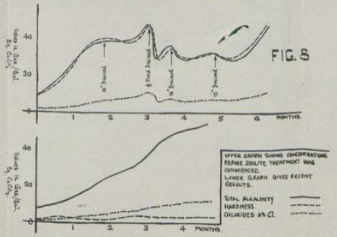


FIG. 8



APPENDICES.

APPENDIX A.

ROUTINE TESTS AND ROUGH ANALYSES.

The standard system of measurement throughout is grains per gallon. This is equivalent to parts per 70 000, and so to obtain quantities in terms of parts per 100,000 all results must be multiplied by 1.43.

(1) Hardness:

For this test, standard Wanklyn's Soap Solution was used, purchased ready made up from a firm of wholesale chemists. The solution can be easily made up by dissolving castille soap in alchohol and standardizing by checking against calcium chloride solution.

70 c.c. of the sample of water to be treated are placed in a shaking bottle and soap solution added 1 c.c. at a time from a burette, the mixture being well shaken between each addition. Presently a lather will form, but will disappear on standing for a little while. The amount of soap solution added to produce this effect should be noted, and then further solution added until the lather which forms remains unbroken for at least three minutes—this lather should be at least half-an-inch deep. The total number of c.c.'s of soap solution now added minus one is the hardness of the water in degrees Clark or in equivalent grains per gallon of calcium carbonate.

(2) Phenolphthalein Alkalinity :

70 c.c. of the water to be tested are placed in an evaporating dish, and a few drops of phenolphthalein solution added. If no pink colour results, the alkalinity to phenolphthalein is zero. If the water turns pink add N/50 sulphuric acid from a burette, stirring gently until the colour just disappears. The number of c.c.'s of acid added gives the alkalinity to phenolphthalein.

N/50 sulphuric acid is obtained by diluting a normal solution of acid with 49 times its volume of distilled water. Normal sulphuric acid contains 49.04 grams of pure concentrated acid per litre of normal solution.

(3) Total Alkalinity:

To the dish of water already used in the previous test, add about 10 drops of Methyl Orange Solution, then continue the addition of acid until the orange colour just begins to turn pink, stirring gently as before. The total number of c.c.'s of N/50 acid added for both experiments gives the Total Alkalinity.

(4) Computation of Alkalinities.

By applying the formula given below the results of the two preceding experiments give the quantities of Hydrates, Carbonates and bi-carbonates present, all in terms of grains per gallon of $CaCO_3$

	Bi-carbonates.	Carbonates.	Hydrates.
P= 0	M	0	0
P<½M	M—2P	2P	0
P=½M	0	2P	0
P>½M	0	2(M—P)	2P—M
P= M	0	0	M

P = Phenolphthalein Alkalinity.
M = Total Alkalinity.

(5) Chlorides.

To 70 c.c. of the sample in an evaporating dish add a few drops of potassium chromate solution, just sufficient to tinge the whole sample yellow. Then add standard silver nitrate solution from a burette, stirring gently. When the whole solution just begins to turn pink, the reading of the burette should be taken, and the number of c.c.'s of $AgNo_3$ solution added gives in grains per gallon the chlorides present in terms of chlorine. The standard silver nitrate solution is made by dissolving 4.78 grams of $AgNo_3$ to make 1 litre of solution in distilled water.

(6) Sulphates.

Exactly two pints of water are taken and filtered. The alkalinity is first neutralised by adding a few drops of hydrochloric acid until blue litmus immersed in the water just begins to turn red. Barium chloride solution is then poured in so that about 0.5 gram of the salt is added. After allowing reaction for 15 minutes, the solution is filtered through a previously dried and weighed filter paper, and after all the precipitate had been caught in the filter, the paper is dried and weighed again. The difference in weight is the amount of Barium Sulphate precipitated. The quantity of sulphates present in the amount of water taken, expressed as the sulphion SO_4, is this weight multiplied by 0.412. The quantity in grains per gallon can be calculated, if the weighing has been in grams, by multiplying this latter result by 4×15.43.

(7) Interpretation of Results.

The first point in the hardness test, where a temporary lather is formed indicates roughly the calcium salts sulphates, chlorides and/or carbonates: the difference between this first reading and the final one indicating the magnesium sulphate. chloride and/or carbonate present. Hardness in natural waters is caused entirely by carbonates, bi-carbonates, hydrates, chlorides or sulphates of calcium and magnesium.

If the hardness is equal to the total alkalinity then the hardness is all due to carbonates, bi-carbonates or hydrates, proportions of which have already been ascertained.

If the hardness is greater than the total alkalinity, then the difference between them indicates sulphates or chlorides of magnesium or calcium, while the value of the alkalinity alone indicates hardness due to carbonates bi-carbonates or hydrates. If the hardness is less than the total alkalinity then the presence of sodium carbonate, bi-carbonate or hydrate is indicated to the extent of the differences between them.

Where sodium alkali is indicated, the presence of calcium or magnesium sulphate or chloride can be definitely ruled out, and if any sulphate is present, as shown by the sulphate test, this will most probably be sodium sulphate : similarly, any chloride present under these circumstances will probably be sodium chloride.

In this way a rough idea of the different salts present can be ascertained. It should be noted, of course, that all results concerned with carbonates, bi-carbonates or hydrates have so far been obtained in terms of calcium carbonate and the necessary correction factors should be employed if exact quantities of the individual salts are required. In the same way, chlorides and sulphates are given in terms of Cl_2 and SO_4. For example if 3.2 grains per gallon SO_4 are indicated, and it is known that this is in the form of sodium sulphate; then to obtain the exact quantity of Na_2SO_4 the relative molecular weights would have to be employed.

$$\left.\begin{array}{rcl} Na_2\ SO_4 & = & 142 \\ SO_4 & = & 96 \end{array}\right\} \quad \begin{array}{rcl} Na & = & 23 \\ S & = & 32 \\ O_4 & = & 16 \end{array}$$

$$\text{Thus quantity of } Na_2SO_4 \text{ present} = 3.2 \times \frac{142}{96}$$

$$= 4.73 \text{ grains/gallon } Na_2SO_4$$

Similarly if sodium hydrate is known to be present to the extent of 8.5 grains per gallon equivalent $CaCO_3$

$$\left.\begin{array}{rcl} \text{Molecular weight of } CaCo_3 & = & 100 \\ \text{" " " } NaOH & = & 40 \end{array}\right\} \quad \begin{array}{rcl} Ca & = & 40 \\ C & = & 12 \\ H_2 & = & 1 \end{array}$$

$$\text{Exact quantity of NaOH} = 8.5 \times \frac{40}{100}$$

$$= 3.4 \text{ grains/gallon NaOH.}$$

(8) Tests for dissolved Oxygen.

The sample to be tested is collected in one of the 250 c.c. shaking bottles, the pipe extending to the bottom, and at least five times the capacity of the bottle must be passed through the bottle be-

fore it is carefully removed and the stopper placed so as to avoid air bubbles. If the water is hot, it must be passed through a cooling coil before being collected in the bottle.

To the bottle full of water is added 1 c.c. of mangenese sulphate solution and 3 c.c. of Alkaline potassium iodide using separte pipettes, and allowing the reagents to discharge at the bottom of the bottle. The stopper is replaced, the bottle shaken and alowed to stand for five minutes.

About 3.7 c.c. of hydrochloric acid is added through a third pipette in the same way until all the precipitate is dissolved.

Exactly 200 c.c. are then placed in a flask and if the yellow colour is pronounced, N/40 sodium thiosulphate solution is added from a burette until the colour has almost disappeared. About .5 c.c. of starch solution is now added, and the addition of sodium thiosulphate continued, drop by drop until the resulting blue colour is just destroyed.

The number of c.c.'s of sodium thiosulphate used multiplied by 0.698 gives the c.c.'s per litre of dissolved oxygen present.

The solutions required in the above experiment are made up as follows :—

(1) MANGANESE SULPHATE :
430 grams dissolved in 1 litre of distilled water.

(2) ALKALINE POTASSIUM IODIDE :
700 grams potassium hydroxide.
150 grams potassium iodide.
added to distilled water to make a total of 1 litre.

(3) STARCH SOLUTION :
5 grams of Litners soluble starch in 50 c.c. of distilled water to make a thin paste, then pour quickly into 200 c.c. of boiling distilled water, boiling being continued for a few minutes. A few drops of chloroform are added when cool

as a preservative, and the solution should be kept well stoppered in a dark place. The solution does not remain active for more than a month or so.

(4) SODIUM THIOSULPHATE :
6.205 grams dissolved in distilled water to make exactly 1 litre.

(9) pH Value Tests.

For this measurement a pH test outfit was obtained for a small sum, from the British Drug Houses, Graham Street, London, N1. Full instructions for using this apparatus are included when purchased.

APPENDIX B.

Formulae for Lime and Soda Treatment.

(a) Lime Adjustment.

If the total alkalinity exceeds 2P, insufficient lime is being added, and the quantity in ounces of extra lime per 1,000 gallons of treated water, is given by the following formula :—

$$1.5\ (M - 2P).$$

If the total alkalinity is more than .5 below 2P then an excess of lime is indicated and 1.5 [2P—(M—0.5)] ounces less lime should be added per 1,000 gallons of treated water.

(b) Soda Ash Adjustment.

If the hardness "H", exceeds the total alkalinity, a deficiency of soda ash is indicated and 2.5 (H+0.5—M) ounces more soda ash per 1,000 gallons of treated water should be added.

If the total alkalinity exceeds the hardness by more than 0.5 then too much soda ash is being added and 2.5 M—(H+0.5) ounces less soda ash per 1,000 gallons of treated water is indicated.

The above formulae are for best quality quicklime (90% Ca O) and best quality soda ash (98% $Na_2\ Co_3$).

APPENDIX C.

Apparatus and reagents required for rough water analysis :—

2—250 c.c. shaking bottles.
4 burettes and stand.
Test tubes and stand.
Filter paper.
Filter funnel (large).
2—2 pint measures.
1—100 c.c. measure.
1—1,000 c.c. measure.
2—300 c.c. flasks.
2—300 c.c. beakers.
2—No. 5 evaporating dishes.
1—chemical balance.
1—bell-jar and plate glass slab—to act as drying chamber for filter papers.
3—10 c.c. pipettes.
Glass stirring rod.

Sulphuric acid.
Hydrochloric acid.
Potassium chromate.
Silver nitrate.
Calcium chloride (for drying filter papers).
Barium chloride.
Litmus paper.
Methyl orange solution.
Phenolphthalein solution.
Wanklyn's Soap solution.
Potassium hydroxide.
Potassium Iodide.
Sodium thiosulphate.
Soluble starch.
Manganese sulphate.
Distilled water.

A small breakfast cooker was used for the first stage of drying filter papers.

DISCUSSION.

The President said they had to thank the author for his paper which was of very great interest and importance to those Engineers who had to deal with water problems in connection with their Undertakings. (Applause).

Mr. Milton (Elec. Supply Com.) said the author was to be congratulated upon his very instructive paper, which would be extremely useful as a reference. Unfortunately the copies of the papers to be read at the Convention did not reach him until the evening before he left, but the subject had been passed on to his chemist who had been asked for a few comments on the points raised

by the author. The name of the gentleman referred to was Mr. G. W. Bond, who had asked him to read the following comments upon Mr. Sibson's paper :—

I must congratulate Mr. Sibson on a really excellent paper.

Corrosion Problems in Boilers :

From our experience we fully agree with Mr. Sibson's remarks in connection with corrosion in the Queenstown boilers, i.e., that it is not sufficient merely to increase the pH value of the drum water to inhibit corrosion. We have found that while corrosion of the boiler drums can be largely eliminated by keeping the pH value of the boiler water at over 10, corrosion of the superheater headers and tubes will still continue, this being due to the presence of oxygen in the feed water. Further, we have found that in the case of our high pressure and temperature boilers, that the safe limit of 0.1 c.c.'s oxygen per litre mentioned by Mr. Sibson is far too high. At Salt River Power Station, for instance, corrosion of the superheater headers and tubes still continues to a small extent even though the oxygen content is kept as low as 0.04 c.c.'s per litre and the alkalinity and causticity of the boiler are very satisfactory.

At one time the oxygen content of the feed water at Salt River was very much higher (as much as 1.0), but by passing all the "make up" water through the condensers and, in addition, by "steam sealing" the surge tanks, we have been able to keep the oxygen below 0.05 c.c.'s per litre. In order to reduce the oxygen content to practically zero we are now considering the addition of a small quantity of a chemical deaerator such as sodium sulphite or ferrous sulphate. At Congella Power Station, on the other hand the oxygen content was never more than a mere trace. There has never been any noticeable corrosion of superheater headers and tubes at Congella, though at one time severe corrosion of the drums was experienced

through contamination of the feed water by sea water, through serious condenser leakage. The feed at Congella is now under a caustic soda-sodium sulphate treatment to counteract the effect of sea water contamination.

At Colenso the oxygen content of the feed was very high indeed as the make up is drawn from an open pond, but arrangements were made some time ago whereby all the make up was passed, as at Salt River, through the condensers, with the result that the oxygen content is now about 0.03.

Scale Formation :

We also agree with Mr. Sibson that even with the most efficent lime soda treatment the **residual hardness** cannot be less than 3 grams per gallon, owing to the solubility of calcium and magnesium carbonate. At Colenso we reduce the hardness of the boiler water to nearly zero by the addition of a small amount of disodium phosphate to the **feed** water. This phosphate is added as a conditioner. In addition to reducing the hardness of the boiler water it acts as an inhibitor of caustic embrittlement. At Colenso, Tugela River water is used as "make up." This contains on occasion abundant suspended siliceous matter, which is removed by alumina-ferric, lime and soda ash treatment. The resultant "make up" has a hardness of about 3.5 grains per gallon. This "make up" is then passed through the condensers which act as deaerators, into the feed system where it comes into contact with the di-sodium phosphate.

At Congella all "make up" is evaporated, so that there are no scale troubles as far as the boilers are concerned and the only problem is corrosion of the drums due to sea water. This has been overcome, as has already been mentioned, by the caustic soda—sodium sulphate treatment, care being taken that the correct ration (sodium sulphate to caustic soda) against embrittlement is always maintained. Further, the addition of caustic soda is strictly proportional to the sea water leakage.

At Salt River, Cape Town water was formerly used and this had to be lime treated owing to its corrosive tendencies. Now all "make up" at Salt River is being evaporated. Sea water contamination also occurs here on occasion, owing to condenser corrosion, and the feed water is under a trisodium phosphate treatment to counteract this. Here, too, the addition of phosphate is strictly proportional to the leakage.

Circulating Water :

After lime treatment the minimum residual bicarbonates are, as stated in the paper, about 3 grains per gallon equivalent calcium carbonate.

The author proceeds to discuss the Zolite process and mentions the disability of concentration of sodium carbonate which occurs with time and suggests acid or alternatively electrolytic prevention of dezincification. If the water were first lime treated to reduce calcium and magnesium carbonate concentration, the Zeolite treatment would be effective over a much longer period as the bulk of the calcium and magnesium carbonates would be precipitated. (Applause).

Mr. Foden (East London) said he read Mr. Sibson's paper with very great interest, and he congratulated the author upon it. He regretted that time was so short, because he felt that they could spend a very profitable half-day in discussing such an important subject as the efficiency of a steam electric power station, and so enable the majority of Electricity Undertakings to contribute materially to the Relief of Rates.

Regarding the author's remarks on the condition of water supplies in the coastal belt, he could assure him that the presence and effect of sodium chloride in the water was very apparent. Tap water at East London and samples of rain water showed an immediate reaction to one drop of silver nitrate, av. 14 frs. of sodium chloride per gallon.

Although he agreed that with care a lime and soda process was of assistance in providing a reasonably pure make up of water from natural sources, he could only say it was a compromise, inasmuch that the quality of natural waters was so divergent, due to flood and drought, that it was practically impossible to secure a satisfactorily pure feed water for high pressure and temperature boilers with the lime and soda process. He had found that periodic cleaning of economiser and drums was most satisfactory.

The treatment of these parts at East London was to coat them with Epexior boiler compound and clamp the zinc plates in the steam drum. He was bound to admit that Apexior was expensive but it was cheaper than frequent renewals and final destruction of drum and headers. He noted that the author had made no mention of $C.O._2$ (carbon dioxide), a most prolific source of corrosion.

The problem of rust cones or nodules was common in water tube boilers, particularly where the economiser was integral with the boilers and of steel construction. This form of corrosion was sometimes termed carbonic acid corrosion, and was invariably found in turbine plants where the bulk of the feed water was comparatively pure condensate. Even this feedwater contained oxygen, carbon dioxide and nitrogen. As the latter was an inert gas having no action on either iron or water, the corrosion was definitely caused by either or both oxygen and $C.O._2$

It had been proved that carbonic acid had a decided corrosive action on iron. In experiments carried out, free carbonic acid in the steam was reduced to formic acid in contact with the iron. This in turn dissolved the iron and other chemical action took place resulting in a cone being formed and a highly corrosive acid being imprisoned within the walls of the cone, when the cone was broken away the usual pit was noticed. The most satisfactory inhibitor of this form of corrosion was an

alkali in the form of calcium hydrate or caustic soda. As he was personally averse to turning a boiler into a chemical tank, he considered physical means of treating the water in the shape of evaporators and deaerators more suitable.

He personally considered that there was plenty of scope for improvement in design of economisers, especially in the direction of increasing the velocity of water through the tubes and thereby tending to sweep away the rust cones by the action of the water. A step in this direction was evidenced by the latest designs of Greens and Foster economisers with reference to condenser corrosion and erosions. Copper nickel tubes in condensers and Cumberland process had proved very satisfactory at East London, but local conditions should always be carefully considered. (Applause).

Mr. Horrell (Pretoria) said that undoubtedly this was a most interesting paper, and he would like to offer his congratulations to the author. It was very interesting to them, because for some years they had had all their chemical work done by Johannesburg, but they in Pretoria were now setting up a laboratory and would do this work themselves. He had made a few notes, which he would like to read as follows :—

The author is to be congratulated on his paper dealing with a subject which is of vital importance to the Power Engineer. There is no doubt that the efficiency and low maintenance costs of power plant operation depend among other things on the correct feed water treatment.

The results achieved at the Queenstown Power Station show that routine water testing is essential in a modern power station and is amply repaid in the case of a small plant.

During 1933 the adoption at Pretoria of what proved to be unsuitable feed water treatment, led to the formation of calcium sulphate scale with

the resultant blistering and failure of the boiler tubes. This occurred at a time when the boiler capacity was limited and it gave us rather an anxious time.

The make-up water was taken from the town mains and the analysis was as follows :—

Source of Supply	Permanent Hardness	Temporary Hardness	Sulphates	Chlorides	Alkalinity
Catchment and Springs	NIL	12.7	NIL	TRACE	14.3

(grains per gallon).

It should be noted that permanent hardness was absent and the water actually contained free soda. This make-up water was evaporated and was then pumped direct to the feed tanks. On occasions it was necessary to supplement this evaporated make-up with raw town water.

Due to the priming of the evaporators, and the evolution of the carbon dioxide which simply passed over with the steam the evaporated water was far from being pure. The following is a typical analysis.

Alkalinity	0.28	grains per gallon.
Causticity	Nil	
Hardness	0.14	
Sodium carbonate (equi. $CaCO_3$)	0.14	
Magnesium carbonate (equi. $CaCO_3$)	0.14	

The addition of lime water to the evaporator supply tank did not result in much improvement.

The feed water was passed through a deaerator where it was heated to 140°F. and was then fed to the boilers. Corrosion was found to take place in the economiser and it was assumed that this was due to the carbon dioxide which must have been present; lime was therefore added to the feed tanks together with the sodium sulphate necessary to keep the embrittlement ratio above

3. The addition of the latter salt was necessary owing to the fact that at a pressure of 350 lbs. per square inch practically all the sodium carbonate dissociated to form caustic soda.

In an endeavour to increase the causticity of the feed water and at the same time maintain the embrittlement ratio the quantity of chemicals added to the feed tanks was gradually increased.

In the boilers the solubility product of calcium sulphate was soon reached with the result that it was deposited in the boiler tubes in the form of a hard scale.

Acting on the advice of the Consulting Engineers it was decided to improve the treatment prior to evaporation and a Kennicott Water Softener was installed. In the softener the town water is now treated with lime and soda ash and sulphate of alumina is added to act as a coagulant to remove the finely divided salts which are precipitated.

The addition of soda is necessary owing to the fact that the town water now contains a small amount of permanent hardness. The water fed to the evaporators has a hardness of 3 grains per gallon and the scale formation has been very much reduced.

The addition of lime and sodium sulphate to the feed tanks was discontinued and instead trisodium phosphate was used. This treatment resulted in the removal of the boiler scale, the calcium sulphate being converted to calcium phosphate which was removed when the boiler was blown down.

The phosphate conditioning of the feed water was found to be satisfactory and is still in use. The quantity of trisodium phosphate added to the feed tank is in the neighbourhood of 0.4 ounces per 1,000 gallons of water evaporated. The hardness of the boiler water has been reduced to zero and tests show soluble phosphates to be present to the extent of from 4 to 8 grains per gallon.

The essential point to note in connection with this phosphate treatment of the feed water is that the quantity of phosphates added should be increased until tests show that soluble phosphates are present in the boiling water. In this way the formation of scale is prevented and in addition caustic embrittlement is inhibited.

The phosphates attack vitreous stoneware alarm floats and asbestos hand hole gaskets and these should be replaced with iron flots and steel cased gaskets respectively.

The disadvantage of the phosphate treatment is that the pH. value of the feed water is low (i.e., in the neighbourhood of 7.0) therefore corrosion is likely to take place in the feed lines and economiser.

Mr. Sparks (Pietersburg) after thanking the author of the paper, said he came from a town where they had a great deal of trouble with their boiler water. In the first place ordinary earthenware floats were useless in the boiler, and in the second place they had had to abandon the use of brass and use cast steel At one time they had had to expand their piston rings in the engine about every six weeks, otherwise the engine would start clattering. He did not know the cause of the deterioration of the piston rings. Brass valves were found to be useless, and they had to use some other metal.

From the point of view of oil, this particular water had a very good effect, no oil being found in the boiler. When they opened their new power station and it had been running for three months they discovered a lot of pit marks. They were greatly concerned over this. He went to a great deal of trouble in investigating the matter, and came to the conclusion that the trouble was caused by the coke filter introducing sulphuric acid. The defect was remedied and since then they had had no corrosion at all. When they got this corrosion the holes were pretty big.

He concluded that this form of corrosion was progressive, and when they had cleaned out the rust marks and painted the boiler they had no further trouble. He would like to have Mr. Sibson's opinion regarding the cause of the rust marks. (Applause).

Mr. Councillor McLean (Port Elizabeth) said he had to leave in order to catch the mailboat at Durban, he would like to thank Mr. Sibson for his excellent paper. He also wanted to congratulate the President and the Committee for having arranged to have Mr. Sibson's paper read at the last moment of the Convention. He was sure he was expressing the view of the member for Bulawayo when he said that no better subject than that of water could be discussed that morning (laughter). He would like to thank the President for the very happy time they had spent together, and would wish them all good-bye and good luck. (Applause).

Mr. Brown (Volksrust) while thanking the author of the paper, thought he was entitled to sound a note of warning. This was a chemical matter and he warned them not to make experiments unless they were carried out by a qualified chemist. Where he came from the work had been carried out efficiently during the last ten years, and they had never had any trouble. Corrosion was definitely a matter for a qualified chemist. (Applause).

Mr. Bahr (Klerksdorp) also thanked the author. There was one thing, however, that he objected to :—

The parts (chemicals) in the water should not be given as number of grains per gallon, but as number of parts in 100,000 parts of water in conformity with a Chemist's Analysis.

Corrosion had been a great bugbear to every Municipality. Sometimes even a chemist could not get the better of it. It might be more ad-

vantageous to pay more attention to the **humic** acids in the water, especially where the supply was drawn from dams.

As to corrosion and pitmarks, he objected to some of the things that had been advocated. If they went on chiselling out the pitmarks in a boiler drum or firebox, in the course of time they would have no boiler left. (Laughter).

He had had a long experience, something like 35 years, and his opinion was that if they found pitmarks they should not try to chisel them out, but clean the surface of the steel shell very thoroughly with a steel wire brush and fill in the pitmarks with litharge. They would then see an improvement.

(Addressing the representatives of sea-coast power undertakings):—

To keep corrosion down they should use a lot of sea water for the first filling up and should give the boiler a good boiling out. The resulting very thin scale would keep a lot of corrosion away. Corrosion ruined a boiler and it was for them to see that it was prevented.

It was not the chemist who had the last word, but the experienced man. (Hear, hear).

Mr. Bahr said that the only way of preventing old pitmarks from becoming deeper was by using litharge when everything else had failed.

Mr. Bahr further corrobated Mr. Shermer's remarks on the use of Zinc-plates.

Whenever they are being used to counteract the pernicious influence of electrolysis on iron or steel vessels containing water, the plate-holders or—studs should have a perfectly metallic contact with the metal, to be protected, and the Zinc-plates.

As a last resource, in very obstinate cases, he recommended the substitution of all cuprous alloys used for fittings and being in contact with the water by steel fittings.

Mr. Metelerkemp (Bulawayo) said, the author advocates the treatment of portion of the cooling pond water instead of the make-up.

In Bulawayo, this treatment was tried in addition to the made up water. It was eventually discarded as an uneconomical proposition, due to algæ choking the zeolite plant and thereby increasing the quantity of water required for back flushing and the possible loss of filtering medium.

Mr. Shermer (Reynolds Sons & Partners) said he appreciated the large amount of experimental and research work which Mr. Sibson had undertaken in preparing his most interesting paper. He was not proposing to enter into the discussion at length, but there were one or two points which had been touched upon by other Members in the discussion, and it might interest Members to know something more regarding the removal of oil from feed water by the electrical process which had been mentioned by Mr. Sibson in his paper.

There is such a plant working in South Africa. This plant was made by Messrs. Davis Perrett & Co., who were at one time established in Broadway, Westminster, London, and might still be for all the contributor knew. This plant is installed at the Brakpan Station of the Victoria Falls & Transvaal Power Company, and operates in connection with their condensate discharge from the steam driven reciprocating air compressing units. The plant has been installed for many years, and is operating very satisfactorily.

A similar plant, manufactured locally on the same principle, was installed on one of the Gold Mines in the Springs District. This plant is now out of commission, but it worked satisfactorily for a long period.

It is not always realised how great is the danger of even a small amount of oil being admitted into steam boilers. The parts per 100,000 may appear insignificant, but when the boiler is

operating for perhaps the best part of a year before a shut-down it will be appreciated that the total amount of oil over a long period introduced into the boiler must be tremendous, and with very bad results, as many Engineers have found out.

Most Engineers appreciate that a boiler is not a water softener, and should not be treated as such. All water treatment should take place outside the boiler.

Zinc plates often serve a very useful purpose, but it is advisable that when these are used, they should be secured to the shell of the boiler drum below the water line, by means of collar studs fastened to the steel plates of the boiler shell so as to hold the zinc plates a few inches clear of the boiler plates. By this means a perfect metallic contact is made between the zinc plate and the steel boiler plates.

He agreed with Mr. Chace Brown on the question of the employment of a qualified Chemist in the initial stages of water treatment. The average Municipal Engineer, with his many duties, cannot be expected to have expert knowledge of water treatment, and the first thing to do is to have an analysis made by competent Engineering Chemist, who would lay down a course of treatment which the Engineer could follow, after which an occasional analysis of the treated water should be made to ensure that the correct results are being obtained.

Mr. Clinton (Salisbury) said he would like to express his admiration of Mr. Sibson's paper. One point that had occurred to him was whether a boiler should be made a vessel for chemical compounds. Mechanical devices would not obviate the trouble. In Cape Town it had been found that such devices were not entirely satisfactory. He

suggested that the feed pipes be inspected more closely. If this were done, a considerable amount of corrosion would be detected, which often was not suspected.

Mr. Clutterbuck (Chief Inspector of Factories) said he would like to add a few words in appreciation of the author's contribution. Speaking as one who had some 20 years' experience of boiler inspecion he regretted not being able to support the recommendations of some of the speakers regarding the treatment of pitting. When pitting occurred in a boiler the best procedure was to submit a sample of the feed water to a qualified chemist who would prescribe treatment to meet any particular case. One speaker suggested filling pit holes, another would chip them out, while a third advocated that a certain amount of scale be allowed to accumulate. In his opinion a boiler plate which had become pitted should be cleaned properly down to the bright metal and a suitable protective coating applied.

Mr. Sparks (Pietersburg) said what he wanted to emphasise was that what got into their boilers was a progressivinly corrosive. They spent quite a time in letting in fresh water until the last trace of the trouble disappeared. He did not believe in covering up marks, but in facing facts. In their case their boiler was as good as ever corrosion having disappeared entirely.

Mr. Ashley (Queenstown) thanked Mr. Sibson for the able manner in which he had dealt with this subject. His paper would be of great value to the Association and to those who ran their own plants. Mr. Sibson had correctly represented the position at Queenstown in regard to the trouble they had there with corrosion. Since Mr. Sibson's departure from Queenstown the valves to which he referred to had functioned very satisfactorily, and there was merely a trace of oxygen in the drinking water.

REPLY TO DISCUSSION.

Mr. Sibson in reply said, it is difficult in the short time available to reply adequately to all the points that have been raised by those who have contributed to the discussion, and he proposed to deal in detail with the more important matters and somewhat more superficially with minor points.

He should like very much to thank Mr. Milton, and through him Mr. Bond for his extremely valuable contribution, which adds very materially to the value of the discussion, particularly as it deals with conditions not experienced or referred to in the paper; namely high pressures and temperatures, and coastal factors.

The corrosion experienced in the E.S.C. stations appeared to be principally in the superheaters and other steam spaces and was thus in a different category from the corrosion dealt with in the paper.

There are three factors, at least, controlling the former type of wasting :—the presence of oxygen, the presence of carbon di-oxide and high steam temperatures. Mechanical deaeration eliminates the first two factors, and the possibility of dissociation of steam is not likely, of itself, to be a serious factor in corrosion at temperatures below 1,000°F., though in combination with the gases mentioned, acceleration in the rate of corrosion might be expected. Thus the marked difference in corrosion noted at Congella is almost certainly due to the elimination of dissolved gases.

In regard to the safe limit of oxygen content, this will vary according to the other water and temperature conditions : 0.1 c.c. per litre is in agreement with American practice where water of high pH value is used, and where medium temperatures and pressures, such as obtain in the bulk of our South African steam stations are ruling.

Where evaporators and high temperatures are in use, concentrations as low as .01 c.c. per litre are sometimes called for. As stated in the paper, a combination of mechanical and chemical de-aeration was tried in Queenstown, though unfortunately tests are not available indicating the final oxygen content. This must certainly have been less than .05.

The well-known objection to steam-sealing surge tanks, is condensation of the steam till the tank is full of water and acts merely as an enlargement of the feed pipe; it would be interesting to know how this difficulty is overcome.

Further, in connection with passing make-up water through the condenser, this is likely to cause deposits of scale on the internal surfaces of the condenser, with which the water comes into contact before it has a chance to dilute with the condensate. This would be due to de-aeration and loss of dissolved carbon dioxide, as it would be unlikely that a small residum of scale forming bi-carbonates would not sometimes be present. This difficulty is greatly lessened by adding the make-up to the large body of condensate in the Hot-Well, in accordance with the system described in the paper, thereby increasing the dilution to such an extent that the calcium carbonate would still be sub-saturated and remain in solution when the CO_2 had been driven off.

With regard to dual treatment of feed-water by lime and zeolite, this of course, is justified on economic as well as technical grounds. It was not used at Queenstown, as the quantity of calcium and magnesium carbonates present barely warranted it and a practical difficulty was the need for a considerable pressure head across the Zeolite bed, which would have been difficult to obtain had the mains pressure been broken.

Mr. Foden also contributed valuable coastal experience. He states, however, that variations of concentrations of dissolved salts in raw water due

to flood and drought are a serious obstacle to efficient treatment. This should not be so if the methods of rigorous test, as outlined in the paper, are carried out, and the treatment modified from time to time.

The use of protective paints has, he thought, been adequately dealt with in the paper, and he had nothing to add in this respect.

Mr. Foden is evidently an exponent of the carbon dioxide theory of corrosion. This is a very controversial subject, but the balance of opinion to-day definitely considers carbon dioxide as a minor factor except in the steam spaces and turbine blading, where condensed steam may dissolve sufficient of the gas to render it's pH value less than 7.0.

He congratulated Mr. Horrel on his decision to establish a test department at Pretoria which is a very wise step. He would like in passing, to mention an incident illustrating this.

A gentleman representing a firm of chemical manufacturers called and offered to conduct a free analysis of boiler water and recommend a treatment. Samples were sent him, but a portion was retained and tested in our own laboratory. When the analysis was received, it proved to be correct except in the most important particular, namely, pH value.

On a basis of this analysis a recommendation was made which needless to say, involved the purchase from the firm in question of certain compounds. The error was pointed out and eventually admitted, but had the compound been used as advised, trouble might well have arisen.

Mr. Sparks has given a very interesting description of his troubles, and he (Mr. Sibson) was quite sure that careful analysis and corresponding adjustments would soon dissipate his (Mr. Sparks') problems, and at any rate give him tangible evi-

dence as to how they originate. The symptons stated by him give rise to a curious speculation. The absence of oil, together with the destruction of brass fittings—usually ascribed to caustic soda—suggests the combination of oil with excess of caustic soda to form small quantities of soap.

The pitting referred to was unquestionably electrolytic, probably accelerated by a low pH value. The trouble with pits, as pointed out by Mr. Sparks, is that they are progressive. This is largely due to differences in oxygen concentration in the water confined in the pit and in the general body of drum water. Potential differences are thus produced and corrosion proceeds.

Mr. Brown suggests that Engineers are best advised to leave chemical problems alone, in which point he (Mr. Sibson) quite definitely disagreed. On such vital matters as boiler scaling and corrosion, an Engineer should make himself acquainted with the rudiments of the problem, especially if the most economical results are to be obtained.

There is no necessity for expert knowledge : in fact there is a danger in over-specialization, but it should be well within the reach of the average Engineer to conduct and interpret the ordinary routine tests. The difficulty in the smaller towns, where the Engineer is the general factotum, is getting the time to deal with the problem.

In reply to Mr. Bahr, calculations in grains per gallon are given partly because that system has always been my practice and also because it lends itself to much simpler working and conversion to other values. The presence of humic or other acids in the boiler drums is immediately indicated by the value of the hydrogen-ion concentrations and this has already been covered in the paper.

He did not think it advisable to introduce litharge or other metallic compounds into the boiler drum as a filler for pit marks; corrosion trouble might even be accentuated due to resultant electrolysis.

The building up of a protective coating of scale is advisable only if no other steps to combat corrosion are taken, and even then its efficacy is doubtful while the efficiency of the boiler is likely to be effected.

Mr. Metelerkamp has referred to the possibility of the Zeolite bed becoming clogged by suspended solids. This is inevitable where muddy water is used without a filter in circuit. The Zeolite then acts as its own filter, and though the regular backwashing removes much of the sediment, it will be necessary to clean out the plant periodically.

Mr. Milton (Elec. Supply Com.) asked leave to speak again on this subject, although Mr. Sibson had actually replied to discussions. In replying to discussions, Mr. Sibson remarked upon a previous speaker's statement in connection with the use of certain alloys for condenser tubes at coastal towns where sea water was circulated, and in view of Mr. Sibson's remarks, he felt that the experience of the Commission might be added, to remove any false impressions.

The Commission's experience in this matter gave every evidence that the nature and type of any given alloy required examination under each particular set of conditions and it could not be stated at this stage that any particular alloy would overcome all troubles of corrosion and pitting when sea water was circulated through condensers.

To illustrate this, the Commission's experience at Salt River and Congella Power Stations respectively could be quoted. At both Stations the Cumberland process was in use for the protection of condensers, but the results had proved to be quite different. In the earlier stages of operation of these Stations, the system at Salt River gave every evidence of giving efficient and satisfactory protection, whilst at Congella, however, it appeared that the Cumberland process was almost ineffective.

At first, one could not help gaining the impression that something was wrong with the application of the system at Congella, but that this was an erroneous impression had been proved conclusively by later experience. The answer to the question "Why was it that if Salt River could use the Cumberland system effectively, Congella could not?" has been proved to be "We do not know."

Towards the end of 1933 the Cumberland system was taken out of service at Congella, and from that date the position was certainly no worse for a short period, and thereafter, conditions considerably improved.

With the introduction of additional turbine plant at Congella and Salt River the plant being of larger capacity that that previously installed, the Commission had entered into a period of condenser tube troubles at both stations, although all other conditions, etc., appeared to be maintained. The metal of the tubes at Salt River was analysed and examined, and it was found that from the point of view of both composition and size and structure of the crystals, there was no apparent difference between the new and the old tubes at this station. This meant therefore that Salt River was faced with the problem that had faced Congella from the outset.

The Commission is experimenting with special metal tubes at Salt River, certain passes of the condensers being equipped with the special metal and the remaining passes retaining the tubes supplied at the outset.

Mr. Milton said that the Commission would no doubt be pleased to provide the Association with full information as regards the results of its experiments. In short, the Commission's experience had shown that the use of cupro nichol tubes did not supply a certain solution to condenser tube troubles when salt water was used, nor was the addition of the Cumberland process to condensers infallible.

The President, on behalf of the Association, thanked Mr. Sibson for introducing such a very important subject, and for his very able reply to the points raised in the discussion. (Applause).

The President : That brings us to the end of our agenda. Does anyone wish to raise any question under the heading "General"?

VOTES OF THANKS.

Mr. Councillor Dely (Pretoria) said on behalf of the Association he had been asked to thank the Mayor (Councillor Allison) the Mayoress and other ladies, and the City Corporation for the very fine way in which they had entertained the members of the Convention. The reason he had been asked to do this was due to the fact perhaps that he was one of the first among the members to visit Pietermaritzburg.

They always knew that the people of Maritzburg were famous for their hospitality, and that they made a point of maintaining that reputation. That was manifested in the splendid way in which the Mayor had carried out his duties and the loveable ways of the Mayoress.

The clerk of the weather did his best to make it difficult for their hosts, but notwithstanding everything had gone off well (Applause). In their thanks he thought they should associate their President, Colonel Ewer, who was one of the citizens of Pietermaritzburg (Applause). The thing that had impressed him most that morning was the general knowledge required by Electrical Engineers, and he had come to the conclusion that their profession included all the others, including the medical profession (Laughter).

Mr. Councillor Coppinger (Krugersdorp) said he was afraid that his predecessor had left very little for him to say, but he was very glad to associate himself with all that had been said about the kindness and hospitality of the Mayor and Corporation.

He realised that the standard of hospitality shown was so high that it would be some years before the little town of Krugersdorp would be able to equal it. He found, however, that that time might not be so long, because they had already 5,000 more people than Pietermaritzburg.

He had been impressed by the City's Municipal services and also by the beauty of its surroundings. With these he was not entirely unfamiliar, for he remembered Pietermaritzburg when spruits ran down the streets, and did not think the City was less pleasant then than it was now.

In regard to the value of the Convention, he had been most impressed by the variety of the subjects introduced and the high standard of the discussions and was very glad that his Municipality had authorised him to accept membership of the Association. He realised that it was of the utmost value, not only to Engineers, to have these Conferences, for they gave Councillors an opportunity of understanding and appreciating the work of their engineering staffs.

He wished to express his sincere good wishes for the future prosperity of the Association, which they all hoped would continue to progress. (Applause).

His Worship the Mayor of Salisbury, Mr. Councillor Fereday, said he would like to support what had been said by the previous speakers. Coming from perhaps the furthest point north they, as Councillors, did not perhaps contribute very much to a Convention of that kind. But they certainly learned a great deal. One thing brought home to him was that they as Councillors did not learn a great deal about technicalities of the subjects discussed, they did realise that the Convention, as far as their Engineers were concerned, was definitely worth while. (Applause).

He thought he could speak for the other Municipalities in Rhodesia when he said that they would not have allowed such a Convention to take place without its being attended by their representatives. (Applause).

He would like to say a few words in regard to the hospitality that had been lavished upon them. Last year they had the honour and privilege of entertaining the Convention in Salisbury, where they thought they knew something about the entertaining side of the business, but they had learned a great deal about it in Pietermaritzburg.

The manner in which they had been looked after by the Mayor and Mayoress and the Corporation was something for which they felt deeply grateful. The City had a most excellent Mayor and he had much pleasure in paying a tribute of praise to all those who had made their stay there so happy. (Applause).

Mr. Clutterbuck (Chief Inspector of Factories), on behalf of the Government Department he represented, thanked the Convention for the privilige of being allowed to be present. The Convention had been most instructive and he appreciated it thoroughly. (Applause).

Mr. Rodwell (Johannesburg) asked the Convention to endorse the proposal before them in the usual way. They thanked the Mayor and Mayoress, the City Councillors, the ladies who had so ably entertained their ladies, and all the citizens of Pietermaritzburg who had contributed so heartily to their entertainment, not forgetting their worthy President. (Loud applause).

The Mayor, in reply, said he greatly appreciated what had been said not only by the Councillor members, but also by the representatives of the Government and others. He could assure them that he was voicing the sentiments of his colleagues and the citizens of Pietermaritzburg when he said how glad they were to have had the members of the Association with them. It had

been both an honour and a privilege. To both his wife and himself it had been one of the greatest privileges they had ever experienced, and they were looking forward to the time when they would have an opportunity of renewing the many new friendships they had formed.

He felt sure that the Convention would be returning to Pietermaritzburg at no very distant date, and when they did so they could be assured of a right good welcome.

Councillor Dely and the municipal representative from Krugersdorp had stated that they began their careers in Pietermaritzburg. That proved two things, firstly that Pietermaritzburg was the hub of South Africa, and, secondly, that in order to be an efficient Councillor they must start their career there. (Laughter and applause).

He very much appreciated what had fallen from the Mayor of Salisbury. Both Mrs. Allison and himself had a soft spot for Rhodesia. They had paid two visits to that part of the country and were treated very well indeed, so much so that they were anticipating a return visit to salisbury. Once again he thanked them all on behalf of his wife and himself for their presence, and hoped that the Convention would be the forerunner of many more in that City (Applause).

Mr. Rodwell (Johannesburg) said as a representative of the South African Institute of Electrical Engineers he wanted to express its President's regret at not having been able to attend the Convention. However, he wished them all the best of luck and all success. He (Mr. Rodwell) was in a position to assure the President of the Institute that the Convention had been a huge success and that they regretted that he was unable to be with them (Applause).

The President then declared the Convention closed, and thanked them all for their attendance and interest during the week. (Applause).

Association of Municipal Electricity Undertakings.

of South Africa and Rhodesia.

LIST OF VARIOUS MEMBERS,
as at December, 1935.

HONORARY MEMBERS.

H. J. van der BIJL, Electricity Supply Commission, Johannesburg.

J. ROBERTS, Electricity Supply Commission, Durban.

E. POOLE, Box 147, Durban. (Secretary and Treasurer).

COUNCILLOR MEMBERS.

Adelaide.
Beaufort West.
Bedford.
Benoni.
Bloemfontein.
Cape Town.
Cradock.
Durban.
East London.
Eshowe.
Fort Beaufort.
Fort Victoria.
Gwelo.
Graaff-Reinet.
Johannesburg.
Kimberley.
Klerksdorp.
Kokstad.
Krugersdorp.
Ladysmith.
Middleburg (Tvl.)
Mafeking.
Matatiele.
Pietersburg.
P.M.Burg.
Port Elizabeth.
Paarl.
Pretoria.
Queenstown.
Roodepoort.
Randfontein.
Salisbury.
Springs.
Somerset East.
Springfontein.
Umtali.
Vereeniging.
Vryburg.
Uniington.
Walmer.

MEMBERS.

ASHLEY, T. P. Queenstown, C.P.
BEHRENS, E. A., Port Elizabeth, *(Member of Council)*.
BROWN, G. C., Volksrust, Transvaal.
CLINTON, J. S., Salisbury, S. Rhodesia.
COULTHARD, R. D., Oudtshoorn, C.P.
COPPIN, T. J., Walmer, C.P.
DAVISON, J. G., Port Alfred, C.P.
DEKENAH, G., Ermelo, Transvaal.
DWYER, C. H., De Aar, C.P.
ELLIOTT, A., Uitenhage, C.P.
EWER, G. G., Pietermaritzburg, Natal, *(President)*.
GYLES, J. H., Durban, *(Member of Council)*.
GROOM, H. L., Roodepoort, Transvaal.
GUNTHER, E., Springfontein, O.F.S.
HOURELD, W., Randfontein, Transvaal.
HORRELL, L. L. Pretoria, Transvaal *(Past President)*.
HARVEY, A. Q., Springs, Transvaal.
HOOPER, J., Robertson, C.P.
IVERACH, J., Grahamstown, C.P.
JAGGER, T., Ladysmith, Natal.
JONES, G. E. H., Mafeking, C.P.
KERSTEN, P. G., Windhoek, S.W.A.
KRUGER, J. J., Adelaide, Transvaal.
LAMBE, J. M., East London, C.P.
LATEGAN, J., Boshoff, O.F.S.
LEWIS, S. V. R., Gwelo, S. Rhodesia.
MAIL, W. M., Kokstad, East Griqualand.
MANN, F. C. D., Worcester, C.P.
MILLAR, T., Harrismith, O.F.S. *(Member of Council)*.
MULLER, H. M. S., Uppington C.P.
MULLER, P. J., Krugersdorp, Transvaal.
MORRIS, H. A., Kimberley, C.P.
METELERKAMP, A. R., Bulawayo, S. Rhodesia, *(Past President)*.
MOCKE, T. M., Piet Retief, Transvaal.
NOAKES, C. F. L., Carolina, Transvaal.
NEWCOMBE P. H., George, C.P.
NICHOLAS, I. J., Umtata, Transkei.
PREVOST, H. A., Somerset East, C.P.
RODWELL, A. T., Johannesburg *(Vice President)*.
RALSTON, L., Dundee, Natal.
ROGERS, J., Fort Beaufort, C.P.
RELIHAN, H. J., Paarl, C.P.

ROSS, W. D., Potchefstroom, Transvaal.
ROSSLER, A., Cradock, C.P.
ROSSLER, W., Ladybrand, O.F.S.
RITSON, D. W., Stellenbosch, C.P.
SPARKS, L. B., Pietersburg, Transvaal.
SIBSON, A. R., Graaff-Reinet, C.P.
STEVENS, F., Alice, C.P.
STEWART, D. B., Gatooma, S. Rhodesia.
SWINGLER, G. H., Cape Town *(Member of Council)*.
SIMPSON, H. G., Bedford, C.P.
SMITH, E. F., Mossel Bay, C.P.
WRIGHT, G. R. E., Benoni, Transvaal.

ASSOCIATE MEMBERS.

DAWSON, C., Durban, Natal.
EASTMAN, H. A., Cape Town, C.P.
PHILLIPS, J. W., Bulawayo, S. Rhodesia.
PERROW, F. A. P., Port Elizabeth, C.P.
TUBB, B. H. J., Salisbury, S. Rhodesia.

ASSOCIATES.

BASKERVILLE, C. H., Salisbury, S. Rhodesia.
CASTLE, F., Cape Town, C.P.
CAMPBELL, A. R., Johannesburg, Transvaal.
DELPORT, J. C., Kopjes, O.F.C.
DOBSON, J. H., Johannesburg, Transvaal.
MARCHAND, B., Witbank, Transvaal.
MACAULAY, R., Bloemfontein, O.F.S.
PENTZ, J. O., Port Elizabeth, C.P.
PRICE, E. T., Johannesburg, Transvaal.
PROCTOR, L. B., Johannesburg, Transvaal.
PURVES, H., Boksburg North, Transvaal.
STEWART, G. A., Johannesburg, Transvaal.
SYERS, F. E., Kroonstad, O.F.S.
WEST, J. A., Colenso, Natal.

HAYNE & GIBSON (Pty.) Ltd.
"The Press at Kingsmead"
50 - 60 Ordnance Road,
DURBAN.