PROCEEDINGS

of the

Sixteenth Convention

of the

Association of Municipal Electricity Undertakings.

of South Africa and Rhodesia.

(Founded 1915)

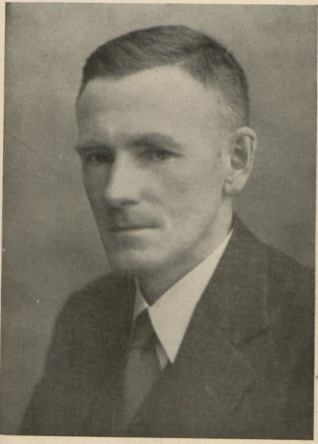
HELD AT

CAPETOWN

From Monday, December 5th to
Saturday, December 10th,

1938.

PRICE SEVEN SHILLINGS and SIX PENCE.



H. A. EASTMAN, PRESIDENT.

PROCEEDINGS

of the

Sixteenth Convention

of the

Association of Municipal Electricity Undertakings.

of South Africa and Rhodesia.

(Founded 1915)

HELD AT

CAPETOWN

From Monday, December 5th to

Saturday, December 10th,

1938.

PRICE SEVEN SHILLINGS and SIX PENCE.

INDEX

Index to Advertisements

INDEX

ASSOCIATION OF

Municipal Electricity Undertakings.

of South Africa and Rhodesia.

Founded 1915.

EXECUTIVE COUNCIL, 1938.

President :

H. A. EASTMAN (Capetown).

Vice-President :

I. J. NICHOLAS (Umtata).

Past Presidents :

J. H. GYLES (Durban).
A. T. RODWELL (Johannesburg).

Councillor Members :

E. SPILKIN (Umtata).
W. JAMES (Cape Town).
G. C. STARKEY (East London). (*Alternate.*)
W. FOWKES (Cape Town). (*Alternate.*)

Other Members :

D. J. HUGO (Pretoria).
J. S. CLINTON (Salisbury).
A. Q. HARVEY (Springs).
G. M. Pirie (Bloemfontein).

Secretary and Treasurer :

E. POOLE,
P.O. Box 147 — Durban.

SUB-COMMITTEES & REPRESENTATIVES.

PAPERS SUB-COMMITTEE:

J. H. GYLES,	Durban.
H. A. EASTMAN,	Capetown.
G. G. EWER,	Pietermaritzburg.
E. POOLE,	Secretary and Treasurer.

RELIEF OF RATES SUB-COMMITTEE:

Clr. W. JAMES,	Capetown.
,, L. HOFMEYER,	Stellenbosch.
,, G. F. ROBBINS,	Pietermaritzburg.
,, J. PARRY,	Springs.
,, E. SPILKIN,	Umtata.
E. A. BEHRENS,	Port Elizabeth.
H. A. EASTMAN,	Capetown.
J. H. GYLES,	Durban.

SUPPLY REGULATIONS SUB-COMMITTEE:

A. Q. HARVEY,	Springs.	
J. H. GYLES,	Durban.	
H. A. EASTMAN,	Capetown.	
G. M. PIRIE,	Bloemfontein.	
G. G. EWER,	Pietermaritzburg.	*Alternates.*
D. J. HUGO,	Pretoria.	*Alternates.*
A. ROSSLER,	Cradock.	*Alternates.*
E. A. BEHRENS,	Port Elizabeth.	*Alternates.*

REPRESENTATIVES—

World Power Conference (Local Committee):

A. RODWELL,	Johannesburg.

South African Standards Institution:

A. Q. HARVEY,	Springs.
G. R. E. WRIGHT,	Benoni (*Alternate*).

Safety First Committee:

A. RODWELL,	Johannesburg.
G. R. E. WRIGHT,	Benoni.

ASSOCIATION OF

Municipal Electricity Undertakings.

of South Africa and Rhodesia.

PAST OFFICERS AND MEMBERS OF COUNCIL.

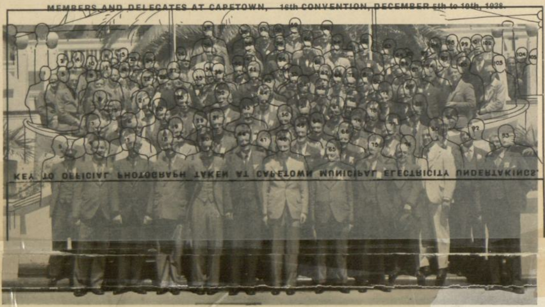
	Past Presidents :		Sec. and Trea. :
1915-17	J. H. DOBSON,	Johannesburg.	F. T. Stokes : E. T. Price.
1917-19	J. ROBERTS,	Durban.	E. Poole.
1919-20	B. SANKEY,	Port Elizabeth.	E. Poole.
1920-22	T. C. W. DOD,	Pretoria.	L. L. Horrell.
1922-24	G. H. SWINGLER,	Cape Town.	H. A. Eastman.
1924-26	J. ROBERTS,	Durban.	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.
1935-36	G. G. EWER.	Pietermaritzburg.	E. Poole.
1936-37	A. RODWELL	Johannesburg.	E. Poole.
1937-38	J. H. GYLES,	Durban.	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.
1935-36 Councillors J. McLean; T. P. Gray; H. W. Daly (alternate) G. H. Swingler; J. H. Gyles; T. Millar; E. H. Behrens.
1936-37. Councillor H. Middlebrook (Durban); T. P. Gray (Johannesburg).
Councillor alternates, F. Morrell (Cape Town); J. McLean (Port Elizabeth).
Engineers, G. H. Swingler; T. Jagger; E. A. Behrens; G. M. Pirie.
1937-38 Councillors H. G. Capell (Durban); W. James (Capetown).
Alternate Councillors, H. Middlebrook (Durban); L. Hofmeyer (Stellenbosch).
Engineers, L. L. Horrell (Pretoria); J. S. Clinton (Salisbury); A. Q. Harvey (Springs); G. M. Pirie (Bloemfontein).

Association of Municipal Electricity Undertakings

of South Africa and Rhodesia.



CONVENTION DECEMBER, 1938. (Photo by courtesy "Cape Times")

No.	Name	From	Visitor, etc.
1.	E R. Smith	Johannesburg	*Visitor*
2.	G. H. Swingler	Capetown	
3.	J. L. Hill	Johannesburg	*Visitor*
4.	P. Frank	Johannesburg	*Visitor*
5.	E. Poole	Durban	*Sec. & Treasurer.*
6.	A. Q. Harvey	Springs	*Mem. of Council.*
7.	W. H. Bottomley	Pretoria	*Visitor*
8.	Clr. C. M. McComb	Springs	
9.	C. Gunyon	Capetown	*Visitor*
10.	R. D. Coulthard	Oudtshoorn	
11.	E. W. Sours	Johannesburg	*Visitor*
12.			
13.	H. Heyer	Capetown	*Visitor*
14.	C. K. Wilson	Capetown	*Visitor*
15.	H. A. Tinson	Johannesburg	*Visitor*
16.	Clr. G. F. Robbins	Pietermaritzburg	
17.	Clr. L. W. Deane	Johannesburg	
18.	G. M. Pirie	Bloemfontein	*Mem. of Council.*
19.	C. E. Scott	Capetown	*Visitor*
20.	F. Stevens	Ladysmith	
21.	Clr. N. St. Quintin	Salisbury	
22.			
23.	G. W. R. le Mare	Johannesburg	*Visitor*
24.	J. C. Robertson	Capetown	*Visitor*
25.			
26.	H. B. Lee	Capetown	*Visitor*
27.	Clr. C. J. Kloppers	Randfontein	
28.	Clr. A. C. T. Bloe	Port Elizabeth	
29.			
30.	D. J. Hugo	Pretoria	*Mem. of Council.*
31.	Clr. A. A. Webb	Benoni	
32.	E. A. Behrens	Port Elizabeth	
33.	A. Baker	Capetown	*Visitor*
34.	Clr. H. Mills	Nigel	
35.	P. J. Muller	Krugersdorp	
36.	Clr. G. L. E. Venter	Cradock	
37.			
38.			
39.	A. E. Robinson	Capetown	*Visitor*
40.	H. Bickley	Nigel	*Visitor*
41.			
42.	B. Marchand	Witbank	
43.	A. Rossler	Cradock	
44.	Clr. H. G. Capell	Durban	
45.	Clr. J. Watt	Johannesburg	
46.	H. A. Eastman	Capetown	*President.*
47.			
48.	Clr. E. Spilkin	Umtata	*Mem. of Council.*
49.	H. R. Bevington	Knysna	
50.	Clr. A. S. Holland	Johannesburg	
51.	W. M. Mail	Kokstad	
52.	W. Horrell	Pretoria	*Visitor*
53.	R. Macaulay	Pretoria	
54.	G. R. E. Wright	Benoni	
55.	W. Houreld	Randfontein	
56.	A. Elliott	Uitenhage	
57.	S. N. Roberts	Capetown	*Visitor*
58.			
59.	E. H. Berry	Johannesburg	*Visitor*
60.	Dr. O. H. Hahn	Johannesburg	*Visitor*
61.	Clr. G. C. Hubber	Randfontein	
62.	W. Rossler	Ladybrand	
63.	J. A. England	Johannesburg	*Visitor*
64.	J. W. Phillips	Bulawayo	
65.	J. H. Gyles	Durban	*Past President*
66.	C. N. Sims	Graaff Reinet	
67.	G. E. H. Jones	Mafeking	
68.			
69.	T. M. Mocke	Piet Retief	
70.	F. C. D. Mann	Worcester	
71.	—. Whitmore	Capetown	*Visitor*
72.	T. J. Coppin	Walmer	
73.	H. Relihan	Paarl	
74.	P. H. Newcombe	George	
75.	A. Foden	East London	
76.	A. T. Rodwell	Johannesburg	*Past President*
77.	Clr. L. Hofmeyr	Stellenbosch	
78.	D. W. Ritson	Stellenbosch	
79.	F. D. Opperman	Capetown	*Visitor*
80.	C. Runtzler	Port Shepstone	
81.			
82.	G. Mortimer	Johannesburg	*Visitor*
83.	F. N. Prangnell	Capetown	*Visitor*
84.	H. L. Shermer	Johannesburg	*Visitor*
85.			
86.	J. Iverach	Grahamstown	
87.	W. I. Seller	Boksburg	
88.	F. Castle	Capetown	*Visitor*
89.	W. H. Milton	Johannesburg	
90.	G. G. Ewer	Pietermaritzburg	
91.	Clr. J. Parry	Springs	
92.	R. D. Ross	Potchefstroom	
93.	P. J. Muller	Krugersdorp	
94.	L. L. Horrell	Pretoria	
95.			
96.	Clr. D. Nelson	Paarl	
97.	Clr. P. C. Bishop	Durban	
98.	T. P. Ashley	Queenstown	
99.	D. A. Thomson	Bloemfontein	*Visitor*
100.	Maj. S. G. Redman	Johannesburg	*Visitor*
101.	C. S. Davy	Johannesburg	*Visitor*
102.	Clr. S. J. Dickason	Fort Beaufort	
103.	J. Rogers	Fort Beaufort	
104.	A. Heydorn	Johannesburg	*Visitor*
105.	H. Bahr	Klerksdorp	

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 toether.

(c) To arrange and hold periodical 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 Undertakins.

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 Hon. Members and Engineer 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 training in Electrical Engineering and is otherwise acceptable by the Council of the Association. Any duly qualified Assistants in an Undertaking with sales of over 20,000,000 Units per annum may also be admitted to this Class on the recommendation of the Chief Electrical Engineer.

(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 contributions shall apply :—

up to ½ million	2 guinneas.
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 Members or Associates 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 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 Association, 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.

Sixteenth Convention.

CAPETOWN.

Programme

Sunday, 4th December, 1938.

8.30 p.m.—Meeting of Council.

Monday, 5th December, 1938.

9.0 a.m.—Registration, Issue of Papers, etc.

10.30 a.m.—Official opening of Convention by His Worship the Mayor of the City of Capetown.

10.45 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. Place of meeting of next Convention.
6. Election of Officers.
7. Other competent business.

The following are the retiring Officers:—

President —J. H. Gyles: Durban.

Vice-President —H. A. Eastman: Capetown.

Past Presidents—A. T. Rodwell: Johannesburg.
G. G. Ewer: Pietermaritzburg.

Other Members—Cnclr. H. G. Capell: Durban.
" W. James: Capetown.
" H. Middlebrook: Durban (Alternate).
" L. Hofmeyr: Stellenbosch (Alternate).
Engr. L. L. Horrell: Pretoria.
" J. S. Clinton: Salisbury.
" A. Q. Harvey: Springs.
" G. M. Pirie: Bloemfontein

12.45 p.m.—Luncheon at the Del Monico Restaurant (by kind invitation of His Worship the Mayor and Council of the City of Capetown).

2.30 p.m.—Drive around Chapman's Peak.

Tuesday, 6th December, 1938.

8.30 a.m.—Council Meeting.

9.30 a.m.—Paper by Mr. E. Stubbs (Capetown Electricity Department) "Notes on the Distribution System of the City of Capetown." Discussion on paper by Mr. C. Kinsman (Durban) "Earthing in Relation to Low Tension Supplies of Electricity" submitted at the previous Convention.

12.45 p.m.—Luncheon Adjournment.

2.15 p.m.—Official Photograph.

2.30 p.m.—Visit to new Table Bay Harbour Construction Works (by kind invitation of the S.A.R. & H. Administration).
(Weather permitting.)

8.0 p.m.—Civic Reception and Dance at Muizenberg Pavilion (by kind invitation of His Worship the Mayor and Council of the City of Capetown).

Wednesday, 7th December, 1938.

8.30 a.m.—Council Meeting.

9.30 a.m.—Paper by Mr. Hooper (Robertson) "Notes on the Operation of Small Pulverised Fuel Plant." Description illustrated by films, slides, etc., of Table Bay Power Station.

12.45 p.m.—Luncheon Adjournment.

2.30 p.m.—Visit to Table Bay Power Station.

Thursday, 8th December, 1938.

8.30 a.m.—Council Meeting.

9.30 a.m.—Paper by Mr. W. H. Milton (Electricity Supply Commission) "Automatic Plants for Small Municipal Schemes."
Notes by Mr. G. H. Swingler (Capetown) "Further Development of the Domestic Load in Capetown.

12.45 p.m.—Luncheon Adjournment.

2.30 p.m.—Official Opening of Water Clarification Plant at Kloof Nek.

8.15 p.m.—Orchestral Concert at City Hall (by kind invitation of His Worship the Mayor).

Friday, 9th December, 1938.

8.15 a.m.—Council Meeting.

9.0 a.m.—Leave for Stellenbosch.

10.15 a.m.—Welcome by His Worship the Mayor of Stellenbosch.
Paper by Mr. L. B. Sparks (Pietersburg) "The Management of a Small Municipal Electrical Undertaking."
Paper by Mr. F. C. D. Mann (Worcester) "Further Notes on the Guiding Policy of a Municipal Electricity Department Undertaking and its Results."

12.45 p.m.—Picnic Lunch (by kind invitation of His Worship the Mayor and Council of Stellenbosch).

2.30 p.m.—Return to Capetown via Fransch Hoek and Sir Lowry's Pass.

Saturday, 10th December, 1938.

8.30 a.m.—Council Meeting.
9.0 a.m.—General Business.

NOTES.

The Convention will close at 10.30 a.m. sharp, giving ample time to those who intend to embark on the outgoing mail boat.

Association of

Municipal Electricity Undertakings.

of South Africa and Rhodesia.

MEMBERS AND OTHERS ATTENDING THE CONVENTION.

HONORARY MEMBERS:

Dr. H. J. van der Bijl. L. L. Horrell. E. Poole.

ENGINEERS AND COUNCILLORS :

BENONI—
G. R. E. Wright.
Councillor A. A. Webb.

BOKSBURG—
Councillor Mrs. Meyer.
,, F. H. Naeser.
W. J. Seller.

BLOEMFONTEIN—
G. M. Pirie.
Councillor L. W. Deane.

BULAWAYO—
J. W. Phillips.

CAPE TOWN—
H. A. Eastman.
A. Edge.
E. Stubbs.
G. H. Swingler.
Councillor W. James.
,, W. Fowkes.

CRADOCK—
A. Rossler.
Councillor G. L. E. Venter.

DURBAN—
J. H. Gyles.
Councillor P. C. Bishop.
,, H. G. Capell.

EAST LONDON—
Councillor G. S. Starkey.
A. Foden.

FORT BEAUFORT—
Councillor S. J. Dickason.
J. Rogers.

GEORGE—
P. H. Newcombe.

GRAHAMSTOWN—
J. Iverach.

GRAAFF-REINET—
C. N. Sims.

JOHANNESBURG—
A. T. Rodwell.
Councillor J. Watt.
,, A. S. Holland.

KLERKSDORP—
H. Bahr.

KNYSNA—
H. R. Bevington.

KOKSTAD—
W. Mail.

KRUGERSDORP—
G. J. Muller.
Councillor L. Friedman.
,, W. G. Delport.

LADYBRAND—
W. Rossler.

LADYSMITH—
F. Stevens.
Councillor H. Quick.

MAFEKING—
G. E. H. Jones.

NIGEL—
H. Bickley.
Councillor H. Mills.

OUDTSHOORN—
R. D. Coulthard.

PAARL—
Councillor G. J. J. Moolman.
Councillor D. Nelson.
H. J. Relihan.

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

PIETERSBURG—
L. B. Sparks.

PIET RETIEF—
T. M. Mocke.

PIETERMARITZBURG—
G. G. Ewer.
Councillor G. F. Robbins.

PORT ELIZABETH—
E. A. Behrens.
Councillor A. C. Bloe.

PORT SHEPSTONE—
C. Runtzler.

PRETORIA—
D. J. Hugo.
Councillor F. Hopf.

QUEENSTOWN—
T. P. Ashley.

RANDFONTEIN—
W. Houreld.
Councillor G. C. Hubber.

ROBERTSON—
J. Hooper.

SALISBURY—
J. S. Clinton.
Councillor N. St. Quintin.
,, R. L. Phillips.

SPRINGS—
A. Q. Harvey.
Councillor C. M. McComb.
,, J. Parry.

STELLENBOSCH—
A. N. Bosman (Mayor).
Councillor L. Hofmeyer.
W. Blersch (Town Clerk).
D. W. Ritson.

UMTATA—
Councillor E. Spilkin.

UITENHAGE—
A. Elliott.

VEREENIGING—
Councillor W. J. Ball.

WALMER—
T. J. Coppin.

WORCESTER—
F. C. D. Mann.

ASSOCIATE MEMBERS :

B. Marchand, Witbank; F. Castle, Capetown; R. Macaulay, Pretoria.

SUNDRY DELEGATES :

Electric Control Board :	J. L. Hill.
Electricity Supply Commission :	A. M. Jacobs, W. H. Milton, G. W. R. Le Mare, Johannesburg; H. J. M. Layzell, Capetown.
Union Government :—	
S.A. Railways & Harbours :	J. Craig, Harbour Engineer, Capetown.
Labour & Social Welfare :	J. A. Mills, Capetown; C. H. Clutterbuck, Pretoria.
Public Works (Electrical) :	W. H. Bottomley, Pretoria.
World Power Conference :	G. R. D. Harding, Johannesburg.
Capetown University College :	Professor B. L. Goodlet.
Sundry Visitors :	J. L. Castleden, Billericay, Essex ; D. W. Thomson, Bloemfontein.

ELECTRICAL TRADES :

A.E.G. Engineering Co. Ltd. :	A. Heydorn, A. Singer, W. Wegener.
British General Electric Co., Ltd. :	A. Baker, C. Gunyon, A. R. van Ryneveld, A. E. Robinson.
B.I.W. Co., Ltd. :	F. Castle, S. C. Morton.
Crompton Parkinson, Co., Ltd. :	R. W. Wright.
Dowson, Dobson & Bahr :	E. A. Dawes.
Hubert Davies & Co., Ltd. :	F. D. Opperman.
S.A. Lamp Association :	C. N. Berry.
Merz & McLellan (S.A.) :	S. G. Redman.
Johnson & Phillips (S.A.) Ltd. :	J. A. England.
Metropolitan-Vickers Co., Ltd. :	T. Monk, T. Riley.
Parsons & Co., Ltd. :	H. M. Rochester.
Rice & Diethelm, Ltd. :	W. L. M. Horrell.
Reyrolle & Co., Ltd. :	W. J. Gibbons, F. N. Prangnell.
Reynolds Sons & Partners, Ltd. :	N. Reynolds, C. S. Davy, H. L. Shermer.
S.A. General Electric Co., Ltd. :	H. A. Tinson, M. Georgala, F. Kuttel.
S.A.C.M.A. :	E. R. Smith.
S. A. Phillips, Ltd. :	F. G. H. Richardson.
C. E. Scott (Pty.), Ltd. :	C. E. Scott.
Siemens S.A., Ltd. :	H. Heyer, Dr. O. H. Hahn.
Stewarts & Lloyds, S. A. Ltd. :	C. K. Wilson.
Vacuum Oil Co. of South Africa :	G. B. Godwin, J. C. Robertson.
Waygood-Otis :	I. C. McGregor, R. H. Buchanan, R. G. Edwards.
Wilson & Herd :	W. M. Herd.

LADIES :

Mesdames : Ashley; Alrick; Behrens; Bevington; Bloe; Buchanan; Castleden; Bottomley; Castle; Coulthard; Edwards; Eastman; Friedman; Gyles; Houreld; Harvey; Jones; Lee; Mocke; Mail; Marchand; McComb; Parry; Poole; Quick; Ritson; Reynolds; Runtzler; Shermer; Seller; Smith; Starkey; Swingler; Venter; Wright, and Miss Gyles.

OFFICIALS :

A. Mitchell, Reporter (Durban); H. B. Lee; W. Tarlten; Miss Y. Grant; Mrs. Best; Miss Perkins; E. Poole, Secretary and Treasurer (Durban).

PROCEEDINGS
OF THE
Sixteenth Convention
MONDAY, 5th December, 1938.

INTRODUCTORY.

THE Sixteenth Convention of the Association of Municipal Electricity Undertakings (Union of South Africa and Rhodesia) was opened in the Ball Room of the Arthur's Seat Hotel, Sea Point, Capetown, at 10.30 a.m. on Monday, 5th December, 1938, and was attended by representatives from 41 Municipalities, including 33 Councillor Members, 39 Engineer Members, 4 Associates, 8 Engineer Visitors, 39 Trades representatives, 11 sundry Visitors, and 38 Ladies.

The President, Mr. J. H. Gyles (Durban) in the Chair: Ladies and Gentlemen, I have very much pleasure in extending a welcome to His Worship the Mayor of Capetown, Councillor Foster, who has kindly consented to open this our Sixteenth Convention. (Applause)

CIVIC WELCOME.

His Worship the Mayor of Capetown (Councillor W. C. Foster): Mr. President, Ladies and Gentlemen,—Sixteen years have elapsed since the last Convention of this Association of Municipal Electricity Undertakings, or, as it was then called, the Association of Municipal Electrical Engineers, was held in Capetown. During that time remarkable progress has been made in the extent to which Electricity is used in the commercial and home life of the Union of South Africa, indeed, more than one-half of the existing Electricity

Undertakings have been established during that period. Correspondingly, during that time the total quantity of Electricity used in the Union of South Africa has increased nearly five-fold from the figure of one thousand million units in 1922.

In the early days Electricity Supply Undertakings were established primarily to enable persons to obtain the convenience of electric light. This, as a principal consideration, has faded into the background, so that at the present time we have come to rely on the supply of electricity as an amenity without which industrial and civic development generally would be impossible. In other words, Electricity, so far from being, as in the earliest days it was considered to be, a commodity in the nature of a luxury, is now, like water supply and roads and transport systems, an essential public service.

This has brought about universal recognition that the supply of Electricity should be rendered either by the bodies having jurisdiction over the area in which this service is rendered, or by other bodies whose activities, particularly in respect to the charges levied, are controlled by statute. members of your Association are well aware, the last point is fully covered in South Africa by the Electricity Act, passed in 1922, and the first is illustrated by the fact that most consumers of Electricity obtain their supplies from Municipally-owned Electricity Undertakings. Individually several of our Municipal Electricity Undertakings in the Union have made such strides as to achieve a measure of progress of which we in this country may well be proud.

As an example, I would mention that in Capetown, despite the handicaps of the Electricity Undertaking being located at a point remote from the inland markets for industrial products, and one thousand miles from the coalfields, we are gratified to find that it has been possible, by the adoption of a progressive spirit of development, to bring about an increase in the annual sales of Electricity from 21 million units in 1922 to 213 million units during the current year. (Applause.) This increase is due principally to the phenomenal growth during that time in the use of Electricity in the home for heating, cooking, refrigeration and many other purposes. As far as can be foreseen at the present time, further substantial increases in the use of Electricity in Capetown will take place for some years to come, even under present-day conditions.

The turn which International affairs has taken during the past few years, however, is such as ultimately to make Capetown one of the principal ports of the world, so that it is reasonable to assume that even still greater progress will be made in the future than in the past in providing that essential service-Electricity. The activities of an Electricity Undertaking cover so much ground that an opportunity such as that given by the holding of a conference of this kind to discuss problems of common interest is of the very greatest benefit in a personal way to those who attend, and even more so to the Municipalities they represent.

I am, therefore, very pleased that on this occasion the City Council and citizens of Capetown have the honour to welcome the Association, and to wish it a very successful series of meetings and a pleasant stay in this the Mother City of South Africa. (Applause.) I hope that those attending this Conference will enjoy their stay among us. We have some things to show you in this Mother City which some people like to call the "grandmotherly city." I am very pleased to see such a number of ladies here, and hope they will have an enjoyable time. I have very great pleasure in declaring the Convention open, and hope that it will be a successful one. (Applause.)

The President (Mr. J. H. Gyles): On behalf of the members of the Association, I should like to thank you, Mr. Mayor, for the very kindly manner in which you have welcomed us to your City. I would also like to say how greatly we appreciate the opportunity of meeting here, and how we appreciate the generous hospitality you are extending to us. (Applause.)

CONDOLENCES.

It is with very deep regret that I have to refer to the death during this year of two of our members—Mr. A. R. Meterlekamp, of Rhodesia, and Mr. A. S. Chalmers, of Blantyre, Nyassaland. Mr Meterlekamp was a Past President of this Association, and had endeared himself to us all. He had a great future before him in the work he had undertaken. I move that this Association places on record its deep sense of the loss it has sustained by the death of Mr. Meterlekamp and Mr. Chalmers, and as a mark of respect I would ask members to stand. (The members then stood in silence.)

Dr. van der Bijl (Chairman of the Electricity Supply Commission), on being invited to address the meeting, said: Mr. Mayor, Mr. President, Ladies and Gentlemen,—I have to thank you, Mr. President, for your kind words of welcome. I regret that it has not been possible for me to attend your Convention more often. I have great faith in your Conventions, the good results of which are seen all over South Africa, and I regret that they are usually held at a time when I am overseas. However, on this occasion I have managed to be here, and I want to assure you that it gives me great pleasure to be with you.

You have remarked upon the growth of Electricity in South Africa, and that growth is due largely to the healthy rivalry among the different towns in South Africa. It is always going forward; one town wants to get ahead of another. When the Commission was formed, I tried to set as a slogan, "a half-penny unit," but only one town came up to it. Now, however, it is a common thing. I remember when I was a little boy in

Pretoria, my father wnated to get this modern amenity of electric light. He dropped into a little office to see if it was possible to get it. The man in the office said something I did not understand, and I remember my father asking him whether it was supplied in a glass or in a tumbler. (Laughter.) That was the position at that time, but now people understand the value of what they receive for their money. That is owing very largely to the work of your Association.

I really think that South Africa is right in the forefront of the modern world in regard to the supply of electric power. If a careful comparison were made it would be found that we are not lacking in any respect. (Applause)

NEW MEMBERS.

The President: I have great pleasure in extending a welcome to the following new Members who have joined our Association.—The Municipalities of Boksburg, Bulawayo, Knysna, Stellenbosch. Engineer Members: H. R. Bevington, Knysna; D. J. Hugo, Pretoria; J. Wilson, Pretoria; C. Kinsman, Durban; A. Foden, East London.

CONFIRMATION OF MINUTES.

The minutes of the last Convention have been circulated, and I will be glad if someone will move their adoption.

On the motion of Mr. Rodwell (Johannesburg), seconded by Mr. Pirie (Bloemfontein), the minutes were unanimously adopted.

HONORARY MEMBER.

I have to announce that your Council have conferred upon Mr. Horrell, of Pretoria, the distinction of honorary membership of this

Association. (Applause.) This honour is due to Mr. Horrell for his valuable services to this Association. (Applause.)

Mr. Horrell: Mr. President, Ladies and Gentlemen,—I do indeed feel that you have done me a great honour in making me an Honorary Member of this Association. I think there are very few left of those who joined the Association in its early days, when we held the first meeting in Johannesburg. That was over twenty years ago, when the Association was a comparatively small affair. Since then I have been very closely associated with it and have spent some very happy times and formed some happy friendships.

I thank you very much indeed for the honour you have done me, and I hope I shall live for many years to attend the Conventions and be amongst you all. (Applause.)

ANNUAL REPORT AND BALANCE SHEET.

The President: I now call upon the Secretary and Treasurer to read the annual report and balance sheet.

SIXTEENTH REPORT and
BALANCE SHEET of the
Association of Municipal Electricity Undertakings
for the period ending August 31st, 1938.

Mr. President and Gentlemen,

I have the honour to present herewith the Sixteenth Report and Balance Sheet covering the affairs of the Association since the 1937 Convention held at Durban.

MEMBERSHIP.

While there has been a few changes and transfers in membership during the past year, our total members remain much about the same, the comparative figures for the past two years being as follows :—

	1937 :	1937 :
Honorary Members	2	2
Councillor Members	51	53
Engineer Members	63	56
Associate Members	2	2
Associates	19	20
	137	133

While the loss in Engineer Members amount to 7, it will be observed that our total loss is only 4, due to transfers to other classes of membership. The losses are chiefly due to retirements of members on reaching pensionable age and resignations from Municipal Service.

Among our members who have retired I would especially mention Messrs. Horrell of Pretoria and Jagger of Ladysmith, both foundation members of this Association since 1915, and we shall ever be indebted to them for the valuable assistance they so readily gave.

In addition to the distinction of President being conferred on Mr. Horrell in 1931, he has also acted as Secretary, Vice President and Past President (the latter from 1933 to 1937) and on his retirement was a Member of Council and we are pleased that he still retains his membership among our Associates.

Mr. Jagger, who is at present resident overseas, was a Member of Council on no less than three occasions and his assistance in representing the smaller Municipalities has been much appreciated.

OBITUARY.

It is with much regret I refer to the death in February last of Mr. A. S. Chalmers, late of Blantyre, Nyasaland, who had been a member of our Association since 1920.

Though not falling within the period of this Report, it is with very deep regret that I refer to the loss this Association has sustained by the tragic death of our esteemed member Mr. A. R Metelerkamp, of Salisbury.

Mr. Metelerkamp had been a member of this Association since 1929 and it was in 1934 we conferred on him the honour of President, and the part he always took in our deliberations and in furthering our aims and objects, leaves most pleasant memories of our association with him.

LICENSING OF ELECTRICIANS.

While it was hoped that the position in regard to the Licensing of Electricians would have been legalised by now it is unfortunate that it was not possible to have had the necessary legislation passed yet.

The Bill was submitted for its second reading in the House on September 16th but was adjourned, and was re-introduced on September 23rd, but as this was a day before the close of the session and there was no time to debate its provisions, it was unfortunately held over until the next session of Parliament.

It is however satisfactory to learn that the measure is at last being considered.

SUPPLY REGULATIONS.

It is regretted that the publication of Supply Regulations has been so long deferred, as at our last Convention it was hoped that they would have been Gazetted early in the year.

It is however expected that they will be available at our Convention.

FINANCIAL.

The financial position of the Association is, I am pleased to say, in a satisfactory position, there being a gain for the year of approximately £123. The Income for the year was substantially increased by the sales of Proceedings and Advertisements; while on the Expenditure side, the Convention expenses was substantially lower than the previous year.

The arrears only amount to £3 16s. 6d. of which £1 1s. 0d. is in respect of a Subscription for the period 1936/37 and which I recommend should be written off as irrecoverable and the name of the member concerned removed from the register.

It will be noticed that our Expenses are not covered by Subscriptions and Advertisements so that members are again asked to assist our funds in the purchase of extra copies of the Proceedings and to endeavour to see that sufficient copies are purchased by their respective Councils, so that at least each member of their Committee is in possession of a copy.

I am,

Mr. President and Gentlemen,

Yours faithfully,

E. POOLE,

30th October, 1937. Secretary and Treasurer

ASSOCIATION OF MUNICIPAL ELECTRICITY UNDERTAKINGS
of South Africa and Rhodesia.

REVENUE AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st August, 1938.

Expenditure :

	£	s.	d.	£	s.	d.
Convention Expenses—						
Reporting	24	3	0			
Printing advance papers	6	12	6			
Programmes and Badges	17	2	6			
				47	18	0
Audit				3	3	0
Statistical Tables				10	0	0
Donation (World Power Conference)				10	0	0
Printing Proceedings				116	5	3
Sundry Printing, Stationery, &c.	13	6	0			
Less sales	1	4	3			
				12	1	9
Salary—Secretary				80	0	0
Secretarial expenses—						
I.M.E.A.	4	18	8			
Postages and Railage	17	5	5			
Telegrams and Phones	1	5	3			
Sundry	2	4	10			
				25	14	2
Bank charges	4	15	4			
Less recovered		9	9			
				4	5	7
Written off—						
Subscriptions, 1935/36				6	6	0
Balance being excess Revenue over Expenditure				122	18	11
				£438	12	8

Revenue :

	£	s.	d.	£	s.	d.
Subscriptions				221	11	0
Proceedings				101	0	0
Advertisements	91	7	0			
	1	8	4			
				89	18	8
I.M.E.A.				5	8	0
Statistical Tables				20	15	0
				£438	12	8

BALANCE SHEET AS AT 31st AUGUST, 1938.

Liabilities :

	£ s. d.	£ s. d.
Accumulated Fund—		
Balance as at 31/8/37	297 18 2	
Plus gain for year ...	122 18 11	
		420 17 1
Add accrued Interest		
Union Loan		38 10 0
		£459 7 1

Assets :

	£ s. d.	£ s. d.
Investment—		
Union Loan Certificate	200 0 0	
Accrued Interest	38 10 0	
		238 10 0
Sundry Debtors—		
Subscriptions for 1936/37	1 1 0	
do. 1937/38	2 2 0	
I.M.E.A. 1937/38	6 0	
Proceedings 1937/38	7 6	
		3 16 6
Cash at Bank		217 0 7
		£459 7 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 shown by the books.

30th October, 1937.

J. C. JOHNSTON, C.A. (S.A.)
Auditor

The President: Will someone move the adoption of the Annual Report and Balance Sheet?

Mr. Swingler (Capetown) moved, and Mr. Horrell (Pretoria) seconded.

Agreed.

ELECTION OF PRESIDENT.

The President: We have to elect a President for the ensuing year, and I have very great pleasure in proposing Mr. Eastman. (Applause.)

Mr. Swingler: I have great pleasure in seconding that. You will remember that at Durban last year, when we were discussing the election of a Vice-President, I stated that I knew that Mr. Eastman would not let you down. My words have come true, as you all know. I congratulate him upon his nomination, and wish him a most successful year of office.

The President: There being no other nomination, it gives me great pleasure to declare Mr. Eastman elected President. I congratulate him most heartily, and wish him a most successful year of office. I now ask Mr. Eastman to take the chair. (Applause.)

Mr. Eastman then took the chair.

The President (Mr. H. A. Eastman): Ladies and Gentlemen, I thank you, and have pleasure in calling upon Mr. Gyles to give us his Valedictory Address.

Retiring President's Valedictory Address

by J. H. GYLES, M.I.EE.: M.(S.A.), I.E.E.
City Electrical Engineer, Durban.

Gentlemen,

As is usual on such occasions, I rise to present my Valedictory Address as President of your Association with mingled feelings of relief and regret —relief in handing over the responsibilities of office to so worthy a successor as Mr. Eastman, and regret at the conclusion of a year of duties which have been so greatly lightened by the loyal assistance which I have received at all times from the other members of the Council of the Association, and particularly from our respected Secretary and Treasurer, Mr. E. Poole, in whose capable hands the affairs of the Association are in good keeping.

Meeting as we are doing here in the mother city of the great sub-continent of Southern Africa, it is impossible for a visitor to fail to realise that we gather under the shadow not only of Table Mountain, but of that great Empire-builder, Cecil John Rhodes, whose dying thoughts were of Tennyson's words—

"So much to do, so little done"

may well be considered true of the activities of this Association. Many of us feel that so little has been achieved and so much still remains to be done, yet what has been accomplished surely gives promise of future greatness. Electricity is the power which it is our privilege to produce and distribute in commercial form, and nothing has played so important a part in the development of modern civilisation as electricity. It has revolutionised industry, it has speeded up communications, it has recently given two new forms of entertainment to the world—"wireless" and "the films,"—and not of least importance, it has come to play a very vital part in the domestic lives of all civilised people within its reach, and its recent use on farms in many countries in creating artificial daylight is claimed to have doubled the production of eggs, while the electric syren has been installed to replace the old-fashioned scarecrow. Many phases of its development have taken place within the memory of living men; it is not yet forty years since the Atlantic was spanned by a radio message; modern electric cooking and refrigeration have taken their full place, in South Africa at any rate, within the past ten years, and we are now at a period of development and expansion in this sphere unequalled in history. The domestic load distribution in this country is generally more widely spread out than in Great Britain or on the Continent, owing to the more general use of houses of the bungalow or two-storeyed types each situated in its own grounds; thus the cost of distribution is increased owing to the lower density of habitation.

Before proceeding to a very brief review of engineering progress in South Africa during the past year, I feel it appropriate to refer to the great loss which we individually, our Association collectively, and engineering circles generally have sustained in the death under such tragic circumstances of a former President of the Association, Mr. A. R. Metelerkamp, who had risen to the important office of Chairman of the Electricity Supply Commission of Rhodesia. In the name of the Association I conveyed the heartfelt sympathy of all its members to his widow, at the same time expressing the belief that he had died as he would have wished to do—on duty. We have also lost through death another respected member of many years' standing, Mr. A. S. Chalmers, formerly Municipal Electrical Engineer of Blantyre, Nyassaland.

While on the personal note I must not omit to mention the retiral on pension during the past year of another former President of our Association, Mr. L. L. Horrell, from the position of City Electrical Engineer of Pretoria. We all trust that he may be spared to enjoy very many years of freedom from the cares of office, and that his experience and ability may be utilised in other spheres of activity. In welcoming his successor, Mr. D. J. Hugo, I do so with a particular sense of pride, as Mr. Hugo is a Natal-born engineer, and his selection for so high an office is a happy augury and precedent for the future. Our good wishes also go out to another of our pioneer members, and incidentally another former colleague of mine, Mr. Thomas Jagger, who retired from the post of Borough Electrical Engineer of Ladysmith during the year, and whose successor is also a Natal man, Mr. Frank Stevens, to whom we also offer our congratulations.

An old proverb tells us that charity should begin at home, and my brief review of engineering progress in South Africa during the past year may well follow suit by referring to doings in Durban, once popularly known as the "Model Borough," but since promoted to the full dignity of a "City." The year has seen the inauguration of many important schemes in every phase of engineering,—the Lower (Natal) Table Mountain Water Scheme, which should supply Greater Durban and the surrounding districts with ample water requirements for the next generation at least; a water-borne sewerage scheme, which will provide sanitary facilities to practically the whole of the areas incorporated into the old borough in August, 1932; a vast plan of harbour development sponsored by the Government, which has taken the wise step of appointing a State Committee to investigate future harbour policy. The Government has also rendered the city invaluable help in its beach restoration work, while large extensions to our General Post Office have been practically completed, and a commencement made on the building of a new Central Railway Station. Complete electrification of the railway tracks from Durban to Cato Ridge has resulted in South Africa gaining the honour of possessing the longest length of single-track electrified line in the world. The short but very important stretch of track between Booth Junction and Wests Station on the Bluff has also been converted to electric traction, while a start has been made on the main line between Booth Junction and Hill Crest.

Improvements, both technical and financial may be expected in respect of the transport problem in Durban by the speeding up of the five years' plan for the gradual elimination of the present tramcar service and the substitution therefor of either trolley vehicles or oil-driven omnibuses, coupled with financial adjustments intended to wipe off accumulated deficits, etc.

The almost unprecedented activity in the building trade throughout South Africa has naturally had its repercussion in the business of electrical contracting, and the services of skilled artisans have been at a premium. The figures representing the value of plans passed for the erection of new buildings and improvements to existing structures in respect of Greater Durban for the twelve months ended 31st July, 1938, only failed by a very small margin to reach the remarkable total of three million pounds.

As regards other centres represented here you will naturally know more of your own home city or town than I can be expected to do, but I mention in passing the great harbour development scheme here in Capetown which, I believe, is fully warranted, apart from commercial reasons, by the vitally important strategic position which the city occupies in relation to the other units of our Commonwealth of Nations; the Rand Water Board's extensions to cost nearly one and a half million pounds; the new Super Power Station now being built for the Johannesburg Municipality; the decision of the Electricity Supply Commission to provide yet another power station, in addition to the large extensions authorised at Capetown, Port Elizabeth, Pretoria, and other centres, and the steady if slow progress of the National Roads Board's twenty million pound scheme for the provision of highways worthy of the cities, towns, and villages they are intended to link. The electrification of the railway route between Johannesburg and Pretoria is a natural corollary to the already electrified Reef lines, and I have read with interest of the proposal to provide illumination along the road joining the two centres just mentioned, an idea in line with the suggestion put forward by me a year ago in my Presidential address in respect of the illumination of all important roads wherever economically possible.

South African industries continue to extend and progress, but as this is a subject more pertinent to the annual gatherings of the Federated Chamber of Industries I shall content myself with remarking on the production by "Iscor" of its millionth ton of steel in May of this year, the decision to establish an electric lamp factory at Port Elizabeth, the assumption of the controlling interest in the cable-making industry in this country by an organisation of the reputation of the C.M.A., and the researches which are being carried out having for their object the production from South African coal of fuel oil and similar by-products.

We as a body must welcome the decision taken by the Union Government during the year to follow the example of the other Dominions by linking up with the International Electrotechnical

Commission, co-operation to be carried out through the medium of the South African Standards Institution, of the Electrical Engineering Committee of which I have the privilege of being a member.

Use of the word "International" tends to recall to mind the gravity of the crisis through which we all to a greater or lesser degree passed only a couple of months ago and the unprecedented preparations and precautions which resulted, the lessons of which cannot and must not be soon forgotten. The abnormal vulnerability of such vital structures as our power stations, with their tall chimneys, massive cooling towers, and other prominent features, must force us to ponder over the results of a few well-directed bombs from enemy aircraft. I note from the overseas technical press that a bomb-proof power station has already been designed, and I cannot be accused of being unduly an alarmist when I urge that the incoming Council of our Association give its earnest and urgent consideration to the problem of affording the fullest possible protection from hostile action to all our power stations, large or small, Municipally-owned or otherwise.

The latest Industrial Census returns have furnished me with many interesting statistics, without some of which such an address as this is always considered incomplete. Of 356 electricity undertakings in the Union, 159 owned by private companies sell seven times as much energy as 197 owned by local authorities, while sixty per cent. of the demands are met by the stations of the E.S.C. and the V.F.P. Company. Light power stations are of over 50,000 k.w. capacity, and 213 are under 1,000 k.w. 379 Prime movers are steam driven, 256 Diesel and heavy oil driven, 37 petrol, paraffin and light oil driven, 38 gas driven, and 37 water-wheel and turbine driven. 4,580,000 tons of Coal were used in a year, costing £1,697,000. Land and buildings for power station purposes are owned by local authorities to a value of £1,749,000, and house machinery worth £11,781,000, the corresponding figures for private companies being £4,378,000 for land and buildings, and £16,433,000 for machinery. The salary and wages bill for 13,096 employees amounted to £1,940,000, and the total expenditure on operating costs, interest, loan redemption and similar items was about £7,300,000 7,605 Route miles of overhead mains and 5,388 of cables are in use, and out of 3,768 million units consumed the mining industry took 2,288 millions, other industries 540 millions, domestic supyly 434 millions, railways 231 millions, and the balance of 275 millions was classed as "Various." Total sales have increased by 120 per cent in the past ten years, and at the present rate of progress it is anticipated that another five years will show a further 100 per cent increase. The units used by the Railways Administration for transport purposes rose from 114 million in 1931/1932 to 188 million for the past year, Natal taking no less than 75 per cent. of this quantity, the Cape 20 per cent, and the Reef 5 per cent. Natal also leads in the average annual consumption per domestic consumer with 2,428 units, followed by the Cape with 1,630, the Transvaal with 1,606, and the Orange Free State with 695, the average for the whole Union being 1,693. Ten undertakings sell current for lighting, cooking, and heating at an average price of less than a penny per unit, and 38 undertakings at between one penny and two pence, while 30 undertakings supply current for industrial power purposes, including mining, at below one penny per unit, and a number supply energy for domestic purposes at ½d. per unit after the minimum number of units at a higher rate has been consumed.

Several instances during recent years of the disastrous result of switch and transformer oil fires have accelerated research work in two particular directions. One trend has been towards the substitution of a non-inflammable wax for the present type of oil, and the other has been towards the air-blast circuit breaker. Research work has produced a synthetic wax which is practically non-inflammable, but at present its cost is somewhat too high for extensive use. A number of circuit breakers arranged for using this wax have been installed on a large municipal undertaking in England, and their performance will be watched with considerable interest. Air-blast circuit-breakers have recently made their appearance in South Africa, several having been installed by the Electricity Supply Commission on 33,000 volt circuits.

Controversy still ranges around the vexed question of contributions from the revenues of Trading Departments in relief of rates. The opposing views have been very ably and exhaustively expressed in recent months. The one undisputable fact is that tariffs and contributions in relief of rates are inseparably bound together, and where large contributions in relief of rates are made, the tariffs must of necessity be higher than they would otherwise be.

In Great Britain the amount which may be contributed in relief of rates is carefully regulated by the Electricity Commissioners, but in South Africa the different Provinces have varying systems. In some, an amount based on a certain percentage of the loan debt is permitted, while in others no limit is imposed, with the result that the amount of the contributions is simply a matter of financial expediency. This is obviously unsound, and I am of the opinion that the matter is of such vital importance that the State should regulate such contributions.

I appreciate the difficulties confronting City Councillors in having to make a choice between increasing the general rate or levying an increased contribution from the Trading Departments. The latter course is somewhat attractive, as it is not so likely to invite criticism from the general body of ratepayers.

In view of this, it can hardly be expected that City Councillors, as a whole, will press for any change in the present system.

I would remind my engineer colleagues of the story of the little boy and the apple, and my advice is, try and reduce tariffs until there is little core left. In these endeavours you will certainly receive the support of the electricity consumers.

In concluding on a personal note, I may mention that this will be the last Convention which I shall attend in full membership, as before the next gathering is due to take place I shall have reached the official Municipal retiring age and shall apply for transfer to the class of Associate. In handing over the Presidency to my successor I wish him a very happy year of office, and to you all I wish highly successful and profitable Conventions, both this year and in future years.

At the conclusion of the Retiring President's address the Convention adjourned for refreshments.

On resuming, the President delivered his Presidential Address.

Presidential Address

by H. A. EASTMAN, B.Sc., A.M.I.E.E., M.I.Loc.E.,
Engineering Assistant, Capetown.

It is with great pleasure that I take this first opportunity of expressing my keen appreciation of the honour you have done me in electing me President of your Association for the ensuing year. I value all the more highly the trust you have reposed in me because this is the first occasion on which the tradition has been broken of selecting for that honour anyone other than the Chief executive of an undertaking. In thanking you for your action as a body, therefore, I would thank especially my chief, Mr. Geo. H. Swingler, the City Electrical Engineer, Capetown, who at the last Convention initiated the train of events that has led to this office falling to me instead of, as might reasonably have been expected, to him.

South Africa, although situated at a great distance from the principal centres for the manufacture of electrical plant and equipment, has consistently been to the forefront in taking advantage of every improvement in the art and technique of the production, distribution and use of electric energy to promote the industrial growth of the country and to improve the standard of living of its inhabitants. Examination of early records shows that electrical installations for public purposes were inaugurated in the larger cities of the Union of South Africa at about the same time, namely from 1890 to 1893, as they were established in the larger centres in Europe, whilst the first plant to be installed for industrial purposes in South Africa was put into operation in the Barberton district in 1892 in connection with gold mining plant. Five years later a 10,000-volt, three-phase transmission line, which was put into operation from Brakpan to Johannesburg, was one of the largest schemes of its kind in the world, and that at a time when there still existed keen controversy in the electrical engineering profession on matters of such fundamental importance as the merits of alternating current as compared with direct current for power transmission.

South Africa's progressive policy since that date is reflected in the fact that there now exists in the Union a number of electricity supply undertakings that rank in respect of output with what are considered as large concerns of their kind in other and more densely populated countries such as the Electricity Supply Commission, whose sales in 1937 amounted to 2,535 million units, the Victoria Falls and Transvaal Power Company Ltd., with sales of electric energy produced in its own power stations of approximately 1,000 million units per annum, whilst the sales of electric energy in three Municipalities is at the rate of between 150 and 250 million units per annum and two company-owned generating plants each produce electric energy for their own use at about the same rate per annum.

The output of the two first-mentioned concerns amounts to about 80% of the total quantity of electric energy used and most of it is supplied to a few large consumers mainly for mining purposes, but the existence of a desire on the part of the population in general to partake of the advantages of the use of electricity is indicated by the fact that up to the end of the Union statistical year 1935/6, the latest for which full particulars have been published, 138 of the 237 Municipalities in the four Provinces and 24 other urban local authorities owned and operated their own electricity supply undertakings and that supplies were being given direct to consumers in a large number of other local authority areas by supply authorities in the vicinity. One hundred of the 162 then existing municipal and other urban local authority electricity undertakings have been inaugurated since 1922.

Still more recent figures published by the Electricity Supply Commission show that no fewer than 24 new local authority undertakings were proposed and 45 others were contemplating extensions of their plant during the years 1936 and 1937.

It is noteworthy that this desire exists not only in the large centres of population but also in remotely situated centres, and that completely self-contained local authority undertakings have been established by communities as small as 500 Europeans and that in addition arrangements to take supplies from other sources have been made by many still smaller groups of inhabitants. Indeed, in this country to no less a degree than in any other, consumers of electricity are to be found readily wherever it is at all possible to come to any reasonable arrangement to make supply available.

The growth in the use of electric energy for all purposes in the Union of South Africa for 25 years ending during the Union statistical period 1935/6 is depicted in curve No. 1, and this may be taken as representing also with a reasonable degree of accuracy the trend of economic conditions obtaining in the country from time to time.

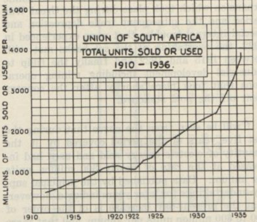


FIGURE Nº1.

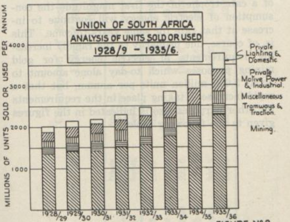


FIGURE Nº2.

C.C.C
Electricity Dept,
Dock Road,
Capetown.
25 11 38

S.F. 919

It indicates very clearly the check to economic expansion which took place during the Great War period and the subsequent trade depression and special internal troubles that were experienced in 1922, the overtaking of the set backs met with between 1915 and 1922 and finally the fillip to industrial development including mining operations that took place shortly after the country went off the gold standard.

It will be seen from the curve that during the last five years of the period covered by it the quantity of electric energy sold and used had increased at the rate of nearly 300 million units per annum. Data published by the principal supply undertakings for later years indicate, however, that the present-day increase is of the order of 500 to 600 million units per annum, and that there is every indication that except for the occurrence of a catastrophe of the first magnitude the consumption of electric energy will continue to increase at that rate for some years to come. This is, of course, due primarily to the rapidly increasing requirements of electric energy for gold mining purposes which to-day alone amount to about 3,000 million units per annum, but that a rapid increase is taking place in the requirements for other purposes also is indicated in the figures given in the following table.

Consumption of Electric Energy (kWH.)
Union of South Africa.
(Millions)

Year	Private Lighting & Domestic Supply.	Private Motive Power & Industrial Supply.	Mining	Tramways	Street Lighting	Railway Traction	Other	Total
1928-29	119.2	213.0	1362.8	38.6	17.6	124.1	132.2	2007.5
1929-30	141.8	228.7	1419.5	39.4	20.5	139.9	137.0	2126.8
1932-33	222.6	249.2	1590.6	40.2	31.9	120.6	207.1	2462.2
1933-34	276.8	355.1	1779.6	42.8	30.9	146.4	222.3	2853.9
1934-35	335.9	411.0	2018.2	44.5	34.2	174.3	228.1	3246.2
1935-36	394.2	539.7	2288.3	42.6	39.5	188.1	275.4	3767.8

A study of this table reveals the interesting fact that during the period under review, notwithstanding the great increase in mining activities, the quantity of electric energy used for other purposes has increased at nearly the same rate as for mining work, the respective figures being :—

Increase in electric energy used for mining purposes :—
925.5 million units.

Increase in electric energy used for all other purposes :—
834.8 million units.

It is worthy of note also that the increase in the use of electric energy for other purposes is contributed to by that used for private motive power and industrial purposes to the extent of 326.7 million units and for private lighting and domestic purposes to the extent of 275.0 million units. That is to say the increase in the electric energy used by private consumers alone accounts for at least 72% of the total increase excluding mining work.

The electricity supply industry in South Africa has in fact developed into one of national importance. It is an essential part of the social organisation, and as a national service it is fundamentally important to our industrial and domestic needs that electricity be made available at the lowest possible cost with the maximum security of supply.

Recognition of the value of—to use a hackneyed phrase—"a cheap and abundant supply of electricity" in the economic life of a country in promoting the establishment of industries and thereby creating and maintaining employment and the circulation of money has been given within recent years by most Governments throughout the world. Indeed there are few countries that have not introduced laws standardising the systems of supply, voltages and frequency and regulating the estab-

lishment of interconnected power stations controlled by bodies to a greater or lesser degree directly responsible to their Governments.

As you are aware, the South African Government took steps in this direction in 1922 when it introduced the Electricity Act, and among the large number of other Governments that before and since that date have acted in a similar manner might be mentioned those of widely differing national characteristics and international interests as Canada, Great Britain, Australia, Germany, Russia, Japan and the Dutch East Indies. It goes without saying that the universal adoption of the principle that the production of electricity should in the interests of economy be on national lines is in itself evidence of the recognition by governing bodies of the essential nature of the service rendered by the supply of electricity to the nation as a whole.

To give effect to the object of the Act in making supplies available at the lowest possible cost to consumers it includes as a fundamental principle that the Electricity Supply Commission, the largest of the undertakers licenced under the Act, shall operate its undertakings at neither a profit nor a loss and is required to adjust its charges accordingly, whilst other licensees are required to refund each year to their consumers pro rata to their payments 25% of the surplus profits of the undertaking for that year, the tariff of charges of all licensees being subject to approval by the Control Board.

The Act, however, does not in any way interfere with the conduct of a Municipal Undertaking in respect of supplies given in its own area of jurisdiction, this being a matter for control by the Provincial Administration of the Province in which it is situated.

It is inevitable that under such circumstances variations should arise in details of carrying out the work of Municipal electricity undertakings. Typical instances in recent years that come to mind are those which led to the standardisation of electricity accounts throughout the Union, the standardisation of electricity supply regulations and regulations for the licensing of electrical wiremen and registration of electrical wiring contractors, in all of which matters our Association took the initiative as well as a leading part in bringing divergent views into line and I hope will continue to do so in the future in connection with all matters that affect the interests of Municipal electricity undertakings however contentious they may be.

While the total quantity of electric energy sold in the Union of South Africa, amounting during the statistical year 1935/6 to approximately 3,768 million units, or even what I think might be regarded as a conservative estimate for the current year of 5,000 million units, is small compared with the corresponding figure of 16,803 million units in Great Britain and 96,000 million in the United States of America, it is of particular interest to find that per head of population (excluding natives) the annual consumption in South Africa in 1935/6 was 1,260 as compared with 366 units per annum in Great Britain and 740 in the United States during the same period. Even when the entire population of 7,750,000 is taken into account the average annual consumption of electric energy is in the region of 700 units per head at the present time. As this basis, rather than the total consumption, is the criterion on which a country may be considered to be "electrified," there are good grounds for saying that in this respect South Africa takes a leading place among other countries.

That South Africa is not backward in making use of electricity for domestic purposes may be judged by the fact that 232,826 consumers in the year 1935/6 used 394 million units for this purpose, giving an average of 1,693 units per domestic consumer per annum, or twice the corresponding figure of 888 applying, according to the latest available figures, for the same period in Great Britain, and 700 in the United States of America.

The average price received by all undertakings for the sale of electric energy is approximately 0.6d. per unit. This extremely low figure is due, of course, mainly to the very large proportion of the total output that is sold to consumers with relatively high load factors from power stations at which the cost of fuel is very low, but even when supply for gold mining and railway electrification purposes is excluded by taking the average price received per unit sold by municipal concerns only, we find the figure to be 0.96d. per unit, which also is lower than the average price of 1,125d. and 1.15d. per unit sold in Great Britain and America for similar classes of supplies. And finally in regard to the development of the electricity supply industry up to the present date, the total capital expenditure involved amounts to no less than £34,352,033, of which approximately one half has been spent on municipal electricity undertakings.

The industry provides employment for 13,096 persons and may be therefore looked upon as providing direct support for about 65,000 persons, and has a salaries and wages bill of approximately £1,940,000 per annum.

In order to cope with the demands for additional supplies that have been made during the past few years on an unprecendented scale it has become necessary to put in hand the construction of new power stations and to extend to their maximum capacity the existing power stations in most of the principal industrial centres of the Union. Some of the new power stations are actually under construction, whilst others are still in the design stage and all incorporate the most up-to-date features of proved modern practice. In the smaller centres also extensions to plant and equipment are being made in many places, and, as I have mentioned previously, there is in addition a steady increase year by year in the number of new undertakings.

This brief review of the present-day stage in in the development of the electricity supply industry clearly shows that the Union of South Africa is in the forefront with other nations in this respect. It must, however, not be overlooked that this development has been due in the main to one section of industrial work, namely gold-mining, the continuance of which for any length of time on the present-day scale, while devoutly to be hoped for, is dependent largely, if not entirely, on international affairs which as a nation we are not in a position to influence to any great extent if at all. It is essential, therefore, for the economic life of the nation that other industries be developed as rapidly as possible, and that this is taking place is evidenced by the fact that, for example, during the past five years the value of the output from private industrial establishments has been increasing at an average rate of approximately £7,000,000 per annum. The basic principle of such development is, however, founded on the development of electrical resources which, in combination with the improvements made of recent years in transport facilities, has given to industrial concerns a greater freedom than they previously had had in selecting the site for their operations. This factor is of importance to municipalities in the effect which the existence or otherwise of a well-managed electricity undertaking may have in turning the scale in favour of or against the establishment of an industry in or adjoining it. To this extent indeed each town may be looked upon as being in competition with its nearest neighbour, and those who do not take every reasonable step to promote the development of its electricity supply undertaking must inevitably suffer to the advantage of others imbued to a greater extent with the spirit of progress.

During the time that the demand has been increasing more rapidly than the rate at which plant has been added to electricity undertakings the latter have been in the fortunate position of being able to make reductions in their charges as a result of lower all-in costs of production, or alternatively, and especially where spare generation and distribution plant capacity has been available, they have been able to make gross profits on a far larger scale than would otherwise have been possible. It cannot, however, be expected that this state of affairs, which has existed for some years in certain undertakings, can continue indefinitely. Cycles of this kind occur continually in the life of every electricity supply undertaking and non-recognition of this fact has in the past brought, and will doubtless in many instances in the future, all warnings notwithstanding, bring up needlessly difficult problems to be solved in the successful working of the undertakings. At the present time, however, the cycle in some undertakings has recurred at a time of steadily rising costs of plant and equipment, fuel, wages and the other incidental costs of production and distribution, and at the same time there is an insistent demand for reductions in the tariff rates and for greater and still greater security of supply, or in short, better service.

While the working costs of production and distribution can, of course, be reduced by taking advantage of technical improvements that are made from time to time, their introduction almost invariably necessitates additional capital expenditure, and the net results may well be, and very often is, that economies made in this way are negatived, at least for some years, not only by the additional capital charges involved in the new plant, but in addition by the financial burden appertaining to plant that has then become a liability rather than an asset.

Various aspects of this question have already been discussed at our Conventions, but there is one to which I think insufficient attention has been drawn, perhaps because it has not arisen, or probably I should say re-arisen, until comparatively recently. I refer to the fact that whereas for some time past the industry has been in the fortunate position of being able to obtain capital for expansion at a cheap rate, there is every indication that for some time to come the interest rate on loans, even for such gilt-edged securities as electricity supply undertakings will be higher than the present-day level and the position to be faced is that money required for extensions to be made in the immediate future will have to be spent at a time of rising prices for plant and equipment on a rising money market and on purchases which will enable the product to be sold at lower prices notwithstanding the steady increase in the unit costs of production. The position can be met fully only by those undertakings that foreseeing the trend of events have taken steps to safeguard their finances to an extent sufficient to tide them over periods of difficulty of this nature. The difficulty is, however, all the more acute for an undertaking that, having adopted a progressive sales policy, has for some time been making the most economical use of its plant capacity but has not thought it necessary to adopt a conservative financial policy to cater for expansion in the future. This acuteness is brought about by the fact that sales development will mostly be in the field of competition with other means of obtaining similar services.

The outstanding financial characteristic of the electricity supply industry is the very great preponderance of fixed or overhead costs in the total cost of production and in the comparatively small return on capital expenditure. The actual working cost of production that varies according to the output from any given station is merely that of the cost of fuel, water, oil and other incidentals in the generation of kilowatt hours and the cost of using some of the kilowatt hours generated in the operation of plant, auxiliary machinery and of electric energy lost in distribution. The whole of the remainder of the total annual expenditure is necessary to keep the undertaking in existence so as to be ever ready to give service. It follows, therefore, that in the broad sense the efficient undertaking is not necessarily that which operates at a high thermal efficiency or any other efficiency while paying due regard to technical efficiency, in addition, makes the most efficient use of its overhead or fixed costs and in particular of its effective capital expenditure. By the latter term is meant the capital effectively in use in the undertaking at the time, that is to say the net outstanding loan indebtedness when taking into account reserves set aside for loan redemption purposes.

As ordinarily the fixed or overhead costs, namely those independent of the actual output in kilowatt hours, exceed very considerably the cost of fuel and other costs corresponding to the output in kilowatt hours, the optimum figure of merit of an undertaking can only be obtained by increasing the output in such a way as to necessitate a minimum of additional capital expenditure, a problem that by its very nature cannot be completely solved. It follows also that in the future in any progressive electricity undertaking profits can only be made on the same scale as hitherto by bringing about increases in the sales at such prices that revenue increases **at a greater rate** than the costs of production. I stress the words "at a greater rate" because with the demands for lower and still lower prices the field of further development in most electricity undertakings will, as I have mentioned previously, be in respect of low-priced units in the competitive sphere.

The method or methods open for application in attaining this result in any particular undertaking will be governed largely by existing circumstances, for example, by the extent to which development has already taken place in the various classes of load, by the tariff rates and by the competition experienced in other means of obtaining similar services. Overriding all these considerations, however, there are two factors that are essential for a successful development plan. Firstly it is essential to inculcate in consumers an appreciation of the advantages of the more extensive use of electricity and secondly for a clear appreciation on the part of Municipalities of the benefits which the development of the electricity supply undertaking will bring to them as a whole by making them more attractive both as residential and industrial areas. I refer to these matters particularly because the histories of most undertakings show that up to a certain point, but one usually far below its latent maximum capacity for usefulness to the community served, an electricty undertaking will grow without any special steps being taken to foster its development. Its growth, however, being haphazard, seldom, if ever, in the nature of things will make for such economic efficiency as that obtainable by systematic development and it is in that direction, no less than in the purely technical work of generation and distribution, that the road leads to truly successful results.

A manufacturer who had installed new machinery to cope with an increase in the demand for his product would naturally be expected to find new markets for all of the goods that his plant is capable of producing rather than to be content to supply merely what further demand might arise without any effort on his part.

A municipal electricity undertaking being essentially a trading concern its activities should be carried out as far as possible strictly on business lines and to attain success it is vitally necessary to inaugurate its systematic development and to take advantage of every opening to promote its interests in the same way as one would expect of any successful commercial enterprise.

Indeed fundamentally the only difference between the working of the ordinary commercial concern and that of a municipal electricity undertaking lies in the object aimed at. In the former case success is measured by the dividends paid to the shareholders, in the latter by the extent to which the undertaking is of value to the community as a whole.

A definition of engineering that well stands the test of criticism in the light of practical experience is "the art of the economic application of science to social purposes." Under that definition the duties of an engineer are twofold. They comprise business management as well as technical direction and this applies not only to the engineering industry in which we ourselves are particularly interested but also to all true engineering work irrespective of its magnitude and kind. That this may be overlooked is illustrated by the suggestion that to my knowledge has been made in all seriousness on behalf of a municipality which was on the point of closing down its own power station in favour of taking bulk supply, to the effect that as the power station would cease to be operated there was no need to employ an engineer. The fact was not recognised that the engineer when relieved of some of his purely technical work would the better be enabled to devote more of his energies to that other part of his duties, namely that of developing the electricity undertaking as a whole, which successfully accomplished would be of far greater value to his employer than the mere supervision of machinery.

Much is being done in the way of educating consumers in the principal urban districts, but the same cannot be said of the majority of municipal undertakings in this country. It may be said that in many of them there is no possibility of development, but I suggest that any such statement is unduly pessimistic. Experience in all parts of the world goes to show that a field of development exists in the most isolated areas when once a desire to make use of the advantages of electricity has been fully brought home to the potential consumers, and that even in those undertakings where extensive development has taken place for many years saturation point is still nowhere in sight. I go so far as to suggest that conditions are unusually favourable for relatively large scale development in many of the smaller communities in this country where because of their geographical location, coal and oil are expensive and wood is practically unobtainable but where at the present time the prices charged for electricity are far beyond the possibility of any real electrical development taking place. If in such places it is said that electrical development for domestic purposes is impossible because of some local reason this will probably be found to be mainly a lack of faith in methods which have proved eminently successful elsewhere.

This is by no means the first time that the attention of our Association has been drawn to these matters. The Chairman of the Electricity Supply Commission himself in 1930 drew attention to the desirability of the inauguration of an electrical development association but the proposal fell through for lack of support. In 1936 a paper was presented drawing attention to the need for informing the consumers of the advantages of the extensive use of electricity, and the Electricity Supply Commission has during recent years given a valuable lead in this direction by means of its publication "ESCOM." This, however, is not enough. Personal endeavour at each centre is required to produce really tangible results.

In making these comments I have had in mind the cultivation of the field for the domestic use of electricity for the reason that it is the most valuable class of load obtainable because of its relatively high load factor and because the use of electricity for this purpose benefits individually the greatest number of persons. Industrial loads in any case cannot be developed unless there are other attractions than the price at which electricity is sold to induce a manufacturer to establish his works in that particular locality. Those other considerations are usually of greater importance than the cost of electricity which in most industries, even at a relatively high price per unit, is a small percentage of the total cost of production, so that literally it may be in many areas impossible under any consideration to develop the municipal electricity undertaking in the direction of industrial supplies, but the domestic field always exists, and when once cultivated will bear fruit to an ever increasing degree and has the further great advantage to the undertaking that it is subject to little or no fluctuations according to the state of trade.

In a profession so closely allied with scientific achievements change follows change in the technique of our work with such rapidity that in many directions what ten years ago was looked upon as sound practice is nowadays superseded by something of far greater economy.

Not many years ago, a thermal efficiency of 25% for the generation of electric energy was considered about the maximum obtainable. Nowadays, however, the highest thermal efficiency obtainable appears to be approximately 30%. There is thus a wide scope for improvement in this direction where at least 70% of the heat energy in the fuel is lost by present-day methods of generation. The field for improvement in transmission and distribution efficiency, which now is in the neighbourhood of 90% in a large undertaking, is comparatively small, but in both of these branches of our work improvements in efficiency have been made obtainable very slowly during the past few years. In consequence of this some would have us believe that because it seems that a stationary state of development is being approached in respect of efficiency of production and distribution no further outstanding departures in methods are likely to take place. On the contrary, past experience has shown that it is just at the very time when a stationary state is reached with present-day methods in matters of economy or efficiency in production methods and particularly when present-day methods are relatively inefficient that the most revolutionary changes are most likely to take place. If then experience is to be taken as a guide, the fact of there being so wide a scope for improving on the present-day methods of generating electric energy indicates that it is in that direction that we must expect the most outstanding changes of this nature to be made.

Progress in the engineering art during our lives has been so rapid as to demonstrate the folly of attempting to forecast the next steps, and one cannot but help being intrigued to read in the technical press of certain experiments that are even now being made in this direction on a laboratory scale.

As I have said earlier, the supply of electric energy is of the nature of a national service and appreciation of the fact that although sales of electric energy in 1937 by municipal undertakings, amounting to approximately 870 million units, was only of the order of 20% to 25% of the total sales for the whole Union of South Africa, this quantity was sold to 260,000 consumers, representing approximately 95% of the total number number of consumers of all undertakings, must lead us to still greater appreciation of the potentialities of our Association, the Association of Municipal Electricity Undertakings, in promoting the welfare of the country as a whole.

The constitution of our Association is such that it is asked, and expects to be represented on bodies whose activities bring them into contact with the work of our members so that, conscious of the fact that on many occasions in the past it has been able to assist in smoothing out difficulties met with by its members, we can with confidence, the more so because of the change made recently in its constitution, expect it to be even better able in the future to assist in solving the various problems that arise from time to time in domestic as well as national matters affecting the supply of electricity by municipalities.

So long as individual local authorities operate their own undertakings it will be necessary for them to foregather to discuss matters of mutual interest, and the results of joint councils in any representations that it may be necessary from time to time to make are much more likely to be fruitful of success than views given individually. The ideals of our Association are high; its interests are wide; and its success has been due to the hearty spirit of co-operation which has always been so strongly in evidence on the part of its members.

While qualities such as these dominate its work there is indeed no limit to the service which our Association can render in the objects for which it was formed twenty-three years ago.

VENUE OF NEXT CONVENTION.

The President: The next item on the agenda is the Venue of the next Convention, and I shall be pleased to receive proposals in that connection.

Councillor Hopf (Pretoria): I understand that at the last Convention our Engineer was asked whether Pretoria would be prepared to extend an invitation to hold the Convention there next year, and he has asked me to state that he readily agrees to the suggestion, but that if there was a feeling that some of the smaller centres should be considered that might be taken into consideration. If the Convention desires its next Convention to be held in Pretoria, I shal be pleased to extend an invitation for it to do so.

Councillor Parry (Springs): I think Springs might be considered, seeing that we have 7,000 consumers and that our progress is not excelled by any town in the world. (Applause and laughter.)

Councillor Spilkin (Umtata): Pretoria has extended an invitation, but I want to say for Umtata that we shall be delighted to welcome the Convention. Years ago I spoke on the question of the small municipalities, which to-day enjoy the larger percentage of your membership. Definitely the large towns have a lot to show us. The most important point is that of accommodation, and when I put the question about holding the Convention at Umtata before my Council they were quite favourable and agreed to it unanimously. We went into the question of accommodation, and I can assure you that we can give you everything you want and as far as social life is concerned we can show you things you have never seen before in your lives. We had a conference there about a month ago, and they sent a letter thanking the municipality for the way in which they had been entertained. I feel that we can cope with the Convention and give you all a very good time. The spirit of the Convention is to help the smaller places. The national road is going through Umtata and you will have everything you want.

Councillor Phillips (Salisbury): I support Umtata, as I do think that the smaller places should be considered.

Councillor Starkey (East London): May I have the privilege of also supporting Umtata's invitation? I do think it will help the smaller municipalities to entertain the Convention, and the whole of the Border area will take it as a compliment.

The President: We have reached the unprecedented position of having three places suggested for holding the next Convention, and I propose, therefore, to put the matter to the vote.

On agreeing to the matter being decided by a show of hands, it was carried by a large majority that the next Convention be held at Umtata.

Councillor Spilkin: Thank you, gentlemen. I hope to see you all there, and can promise you a good time.

The President: I would like to express our appreciation of the invitations extended by the other municipalities. (Applause).

ELECTION OF VICE-PRESIDENT.

The President: We now come to the election of Vice-President, for which I invite nominations.

Councillor Spilkin (Umtata): I move the election of Mr. I. J. Nicholas, of Umtata.

Mr. Mail (Kokstad): I have much pleasure in seconding that.

There being no other nominations, the President declared Mr. Nicholas elected.

PAST PRESIDENTS.

The President: The position on the Council of two immediate Past President is automatically filled by Messrs. A. Rodwell and J. H. Gyles.

ELECTION OF COUNCIL.

The President: We now come to the election of members of the Council.

Mr. Rodwell: In regard to the election of members of the Council, I do think that we need continuation of policy, and I, therefore, propose Councillor James (Capetown) and Councillor Spilkin (Umtata), with Councillor Starkey (East London) and Councillor Fowkes (Capetown) as alternates.

Mr. Horrell: I second that.

Agreed.

The Convention adjourned at 12.58 p.m.

TUESDAY, 6th December, 1938.

The Convention resumed at 9.30 a.m. in the Ball Room, Arthur's Seat Hotel, Sea Point, with the President in the chair.

DATE OF NEXT CONVENTION.

The President: This morning at a meeting of the Council of the Association, it was suggested that the next annual Convention shall be held at Umtata from the 17th to the 20th October, 1939.

After discussion it was, however, decided to refer the matter back to the Council for further consideration.

RELIEF OF RATES.

You will remember that a sub-committee was appointed at the last Convention to discuss the question of the Relief of Rates, and as one of the members of that Committee is not here (Councillor Coetzee, of Springs) the Council suggests that Councillor Parry, of Springs, should be appointed in his place, and that the name of Councillor Spilkin be added to the Committee. Your Council recommend that that be done, and I put it forward for your confirmation.

Agreed.

ELECTION OF ENGINEER MEMBERS OF COUNCIL.

The President: We will now proceed to the appointing of engineer members of the Council, and I call for nominations. The retiring members are Messrs. Horrell, Clinton, Harvey and Pirie.

The following were nominated as engineer members of the Council: Messrs. Ewer, Ritson, Rossler, Pirie, Harvey, Clinton and Hugo.

A ballot resulted in the election of Messrs. J. S. Clinton (Salisbury), A. Q. Harvey (Springs), G. M. Pirie (Bloemfontein), and D. J. Hugo (Pretoria).

WORLD'S POWER CONFERENCE (S.A. COMMITTEE)

The President: The next item is the report of our representative, Mr. Rodwell, on the World Power Conference.

Mr. Rodwell: The Report is very brief and is as follows:—

A sectional meeting of the World Power Conference was held in Vienna from August 25 to September 2. The British delegation was particularly strong, but no South Africans were present.

Few communications have been received and this, no doubt, was due to the unsettled state of Europe and the International crisis which interfered with the work of the Conference as a whole.

A. RODWELL,
Representative of A.M.E.U.

The President: I call for nominations for our representative on the World Power Conference.

The only nomination was that of Mr. Rodwell, who was declared re-elected.

SOUTH AFRICAN STANDARDS INSTITUTION

The President: A Report by your representative on the S.A. Standards Institution is laid on the table for your information.

This report includes the work done by the South African Standards Institution during its third year's activity, for the period 1st June, 1937, to 31st May, 1938.

The Association is represented by the following bodies, who are all members of the Main Committee:—

Department of Agriculture and Forestry.
Department of Commerce and Industries.
Department of Irrigation.
Department of Labour.
Department of Mines.

Department of Posts and Telegraphs.
Department of Public Works.
South African Railways and Harbours Administration.
Association of Mine Resident Engineers.
Association of Municipal Electricity Undertakings of South Africa and Rhodesia.
Chemical, Metallurgical and Mining Society of South Africa.
Geological Society of South Africa.
Institute of South African Architects.
Institution of Certificated Engineers, South Africa.
Institution of Municipal and County Engineers (S.A. Branch).
Natal Institute of Engineers.
South African Institute of Electrical Engineers.
South African Institution of Engineers.
South African Society of Civil Engineers.
British Electrical and Allied Manufacturers' Association.
Electricity Supply Commission.
Natal Coal Owners' Association.
National Federation of Building Trade Employers in South Africa.
South African Chemical Institute.
Rand Water Board.
South African Federated Chamber of Industries.
South African Iron and Steel Industrial Corporation Limited.
Transvaal Chamber of Mines, Consulting Engineers.
Transvaal Coal Owners' Association.
Transvaal Iron and Steel and Engineering Industries Federation.

During the year the sectional committees have considered a number of draft specifications received from British Standards Institution and Standards Association of Australia and New Zealand. All these specifications have been reviewed to ascertain whether such could be used for S.A. Standard Specifications.

Correspondence took place during the year with other territories in South Africa, on the question of closer co-operation, but so far no finality has been reached.

South African Standard Specifications:

During the year the Institution has issued certain Standard Specifications. Those which would be of interest to our Association would be Specification No. 13, 1937, Standard Methods for the Sampling of Coal in South Africa.

There is a S.A. Standard Specification for bricks which is now in its final form, and will be brought into force during the current year.

International Electrotechnical Commission:

During the year the Union Government decided to become a member of the International Electrotechnical Commission, and it was decided that the membership should be effected through the S.A. Standards Institution.

The report of the Electrical Engineering Sectional Committee is included here, which shows clearly what has been done in that section during its year of activity:—

Meetings:

The Committee held nine meetings during the past year. The average attendance at the meetings was seven.

Draft British Standard Specifications:

The following draft British Standard Specifications were considered:—

- *3064 Dimensions of Film Slides.
- 3267 The Flameproof Enclosure of Electrical Apparatus for Power and Lighting Plant. (Revision of B.S.S. No. 229-1929.)
- *3337 Under-floor Steel Duct System for Electrical Services.
- *3489 The Method of Testing Dust Extraction Plant for Power Stations.
- 3672 Rotating Electrical Machinery for Traction Purposes.
- *3779 Vitreous Enamelled Steel Reflectors for Electric Lighting—open dispersive type.
- 2954 Minimum requirements for such Electrical Appliances as are not covered by current British Standard Specifications.

4420 Bell Transformers (excluding Transformers for Use in Mines).

*3785 Electric Signs (Revision of No. 559-1934).

4186 Insulated Annealed Copper Conductors for Electric Power and Light. (Revision and Extension of B.S.S. No. 7-1926.)

4075 Electric Locks for Railway Signalling Purposes.

4421 Electrodes for Spot Welding Machines.

4638 Light-Gauge Seamless Copper and Copper Alloy Conduits and Fittings for Electrical Wiring.

*4897 Under-floor and Non-metallic Ducts with Fittings for Electrical Services.

*4903 Air Break Switches, including Isolating Switches, totally enclosed and flame-proof types for voltages not exceeding 660 volts.

*4904 Air Break Circuit-Breakers, including totally enclosed and flame-proof types for voltages not exceeding 660 volts.

*4928 Electric Water Heaters with Copper Containers from 1½ to 100 gallons capacity and Thermostats for use therewith.

*4930 Transformers for use with Electrically-operated Toys.

5111 Portable Fuse and Plug Boxes for Film Studios.

5189 Electric Lamps for Railway Signalling.

*4569 Steel-cored Copper Conductors for Overhead Power Transmission Purposes.

5826 Pure lac for Electrical Insulating Purposes.

*5899 Electric Circuit Controllers for Mechanical Frames.

6101 Compounds and Methods for the Suppression of Radio Interference, due to Ignition Systems and other Electrical Equipment of Internal-combustion Engines and Automobiles.

6395 Definitions of Heat Insulating Terms and Methods of Determining Thermal Conductivity and Solar Reflectivity.

6956 Draft Revision of B.S. 170-1926, Electrical Performance of Fractional Horse-power Motors.

The Committee submitted comments to London on the draft specifications marked with an asterisk.

Adoption of British Standard Specifications as South African Standard Specifications:

116- Oil Circuit-Breakers, Oil Switches and Oil Isolating Switches for Alternating Current Circuits.

116-Part 1-1937 Three-phase Oil Circuit-Breakers with Breaking-Capacity Ratings up to 500 MVA. Single-phase Oil Circuit-Breakers, Oil Switches and Oil Isolating-Switches.

116-Part 2-1937 Three-phase Oil Circuit-Breakers with Breaking-Capacity Ratings above 500 MVA.

727-1937 The Characteristics and Performance of Apparatus for the Measurement of Radio Interference.

422-1931 Transformer Inter-turn Insulation.

215-1934 Hard-drawn Aluminium and Steel-cored Aluminium Conductors for Overhead Transmission Purposes.

125-1930 Hard-drawn Copper Solid and Stranded Circular Conductors for Overhead Transmission Purposes.

480-1933 Metal-sheathed Paper-insulated Plain Annealed Copper Conductors for Electricity Supply.

168-1936 Electrical Performance of Industrial Electric Motors and Generators with Class "A" Insulation.

Standards Association of Australia:

In a communication received from this body, it was stated that the Government of New South Wales had in course of preparation a number of rules relating to the safety of operatives in overhead line construction. Information was asked concerning any rules in South Africa designed to ensure the safety of men engaged in the erection of overhead transmission lines, maintenance of lines, etc. Through the agency of Mr. C. J. Monk, a copy of the Regulations of the Victoria Falls and Transvaal Power Company was forwarded by the General Manager of the Company to the Association as likely to be of use in the preparation of the operating procedure to be decided upon by the Association.

The following Draft Australian Standard was received:
Code for Street Lighting—To be No. C.A. 19.

The Committee was invited to comment on the specification. Suggestions based on South African practice were forwarded to Australia.

Acknowledgments:

In the consideration of Draft British Standard Specifications and the adoption of British Standard Specifications, the Committee takes this opportunity of recording its appreciation of the help received from members and of the views on specifications received from the following sources:—

Public Works Department.
Department of Posts and Telegraphs.
South African Railways and Harbours Administration.
Municipal Electrical Engineers of Johannesburg, Durban, Capetown, Port Elizabeth and East London.
Electricity Supply Commission.
Victoria Falls and Transvaal Power Company, Ltd.
South African General Electric Company, Ltd.
Rand Carbide Company.

A. Q. HARVEY,
Representative of A.M.E.W.

Mr. Harvey (Springs) was thanked for his Report and unanimously re-elected as the Association's representative on the South African Standards Institution.

Mr. Harvey: I appreciate this compliment. It has not always been convenient for me to be present and I would very much like the appointment of an alternative member, and with your permission would submit the name of Mr. Wright. (Benoni).

Mr. Rodwell: I have pleasure in seconding that, as it is important to have someone at the meetings.

Agreed.

Papers Sub-Committee:

The President: I call for nominations for the Papers Sub-Committee.

The following were duly proposed, seconded and elected:

J. H. Gyles, Past President.
H. A. Eastman, President.
G. G. Ewer, Past President.
E. Poole, Secretary and Treasurer.

Safety First Committee (See Wednesday's Proceedings):

The President: I have pleasure in calling upon Mr. Stubbs, of the Capetown City Electricity Department, to present his paper on "Notes on the Distribution System of the City Corporation."

NOTES ON THE

Distribution System

of the

City of Capetown Electricity Undertaking

and the

Protective and Safety Devices used therein.

by E. Stubbs,
Distribution Engineer, City Electricity Department,
Capetown.

This paper is presented to your Association in the hope that it may prove of interest to the members generally and particularly that it may lead to discussion on many of the points referred to.

It is sometimes an advantage for those engaged in any particular phase of public work to define the results at which they aim. When introducing into the Union Parliament the Electricity Supply Bill of 1922 the Minister of Mines & Industries, Mr. Malan, described the Bill as being inter alia to make available throughout the Union an abundant, reliable and cheap supply of electricity. As this is the professed object of legislation governing all matters connected with electricity supply it may fairly be taken as representing the result which everyone connected with the profession strives to obtain.

In Government Notice No. 425 issued on 9th March, 1926, the following appears :—

> "In the absence of agreement to the contrary, the pressure at which electricity is applied shall not differ from the standard or agreed pressure by more than 5% over a longer period than ten consecutive minutes and the frequency of any alternating current, that is to say, the number of complete cycles per second, shall be 50 and this frequency shall not vary more than 2½% over or below 50".

These Regulations indicate the standard which is expected from us but I wonder how many systems can claim to meet these requirements for a period of twelve months for the whole or even 50% of their consumers.

At first sight it would seem that the three conditions previously mentioned are to some extent contradictory. Abundance and reliability would seem to be antagonistic to cheapness as they can only be obtained by purchasing plant of the highest quality, installing it under well-designed and suitable conditions, and running it with an efficient staff, all of which cost considerable sums of money. The successful solution of the problem is therefore to obtain maximum reliability at the least possible cost.

In most Electricity Supply Undertakings the Transmission and Distribution Systems represent at least 50% of the total capital cost of the Undertaking and it is clear that the efficiency and economy of its design and operation have a very considerable bearing on the results of the Undertaking as a whole. The efficiency of a Distribution System is difficult to assess as there is no accepted standard by which it can be measured as is the case for Generating Stations where the pounds of coal per unit sold or the thermal efficiency of the plant provide a basis applicable to all Stations.

The writer suggests that the number of hours or fraction of an hour that each consumer is without supply during the year might be taken as a standard of comparison. If such a figure were included in the published returns of the different undertakings it might serve a useful purpose in directing the attention of everyone concerned with electricity supply to the necessity of continuity of service. For the year ending December 31st, 1936, these figures were calculated for the Undertaking of the City of Capetown and showed that the total consumer-hours lost from all causes—Generating Station, Transmission and Distribution Systems—represented .4 hour per consumer per annum.

Area Supplied :

The thickly populated area adjacent to the City of Capetown is, for the purpose of electricity supply, divided between the Capetown Undertaking of the Electricity Supply Commission and the City of Capetown Electricity Department and it is the Distribution System of the latter to which these notes refer. Fig. 1 is a plan of the Cape Peninsula and on it is indicated the area in which the Council of the City of Capetown has the right to supply. This includes the whole of the Peninsula, as well as that portion of the Cape Flats to the west of line AB; supply is available in those portions of the area which are hatched. The nature and density of the load vary over wide limits in different parts of the area, from upwards of 10,000 kVA. per square mile in the central parts of the City to a load which, with the cheapest possible construction, is barely a paying proposition in the Rural Areas of Constantia Valley and the Cape Flats.

SYSTEM OF SUPPLY :

There are two Generating Stations run under a pooling agreement between the Electricity Supply Commission and the City Council, both of which

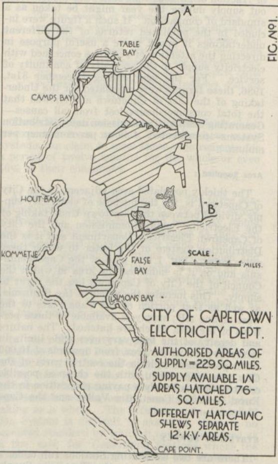


FIG. No 1.
NORTH
TABLE BAY
"A"
CAMPS BAY
HOUT BAY
"B"
KOMMETJE
FALSE BAY
SCALE.
MILES.
SIMONS BAY
CITY OF CAPETOWN ELECTRICITY DEPT.
AUTHORISED AREAS OF SUPPLY = 229 SQ. MILES.
SUPPLY AVAILABLE IN AREAS HATCHED 76-SQ. MILES.
DIFFERENT HATCHING SHEWS SEPARATE 12·K·V· AREAS.
CAPE POINT.

are situated at the north end of the area adjacent to the shores of Table Bay, the generating voltage at both Stations being 33 kV. 3-phase 50-cycles per second.

The first 33 kV. transmission in the Cape Peninsula was installed in 1927 for the purpose of supplying energy for the electrification of the Cape Town—Simonstown Railway, in connection with which substations were constructed at Muizemberg and Glencairn respectively. Arrangements were made with the Electricity Supply Commission for stepdown transformers to be installed in each of these substations to feed the Council's 12 kV. network.

Subsequent to the commencement of generation at 33 kV. at Salt River Power Station in 1932 all the increase in load on the Council's System has been taken by the 33 kV busbars by providing main stepdown substations at Dock Road Power Station, Three Anchor Bay, Sea Point, and Rosemead Av. Wynberg. Each of these main substations feeds its own 12 kV. distribution network as do also coupling transformers at each Generating Station assisted when necessary by the older 12 kV. generating plant. At present there is a total of six 12 kV. Systems, the approximate boundaries of which are indicated by different hatchings on Fig. 1. There are under construction two additional main stepdown substations, one at Newlands and the other in the upper part of the residential district of Capetown, known as the "Gardens." These will be completed about the same time as the Table Bay Power Station comes into operation and there will then be eight separate 12 kV. networks. Normally each of these systems is isolated from the others but the cable arrangements are such that any one can be connected to the adjacent areas if required. This arrangement allows of the transfer of load from one system to another, as may be necessary to meet any unusual circumstances which may arise.

In 1920 3-phase 4-wire distribution at 220/380 volts was adopted as standard and since then any areas with non-standard supplies have been reconstructed and changed over. At that time also we commenced to use substation arrangements which with alterations of details only, have been continued ever since. The arrangement consists of compound filled completely metal-clad 12 kV. switchgear, two transformers per substation, Low Tension iron-clad switchgear with oil circuit breakers on both transformers and outgoing circuits, which in all cases consist of underground 4-core cables (feeders) either connected direct to the overhead reticulation or terminating at a feeder pillar from which two or possibly three sub-feeders are connected to the overhead network.

At first the standard equipment of a substation consisted of two 300 kVA. transformers with usually four outgoing feeders, each .25 sq. in. but as the density of the loading increased larger transformers have been used and the number and sizes of the outgoing feeders have been increased, to six and in a few cases more. Each Low Tension feeder, and where such exists, each sub-feeder, supplies an isolated section of the overhead or underground reticulation.

It follows that the overhead part of the distribution is the simplest possible in that there is only one set of conductors for general supply with street lighting supply wires above the mains. The service connections to consumers' premises are overhead and consist of A.M.E. wires; a 3-phase 4-wire connection being used for every house of four or more rooms. The standard size of conductor used on the overhead network is .1 sq. in. and the loading is therefore limited to about 100 amps in either direction from the termination of the underground feeders. In industrial areas individual factories and in residential areas blocks of flats are often found to have loads in excess of

100 amps. per phase and are fed either by a sub-feeder from a feeder pillar or, if the load warrants it, by one or more cables direct from the sub-station. In the centre of the City the reticulation as well as the feeders are underground, standard sizes being feeders .5 .5 .5 .25 sq. in. 4-core cable and distributors .25 sq. in. 4-core cables.

Many of our substations are located near factories with a connected load which in any case would have required a H.T. supply, the arrangement usually adopted being that the owner of the factory transfers to the Council at a nominal price sufficient ground for a substation. The Council builds and equips the substation giving a standard L.T. supply to the factory and to other consumers in the vicinity. A considerable number of substations which originated in this way now supply a domestic load considerably in excess of that of the original factory load and the policy which has proved to be eminently satisfactotory to all concerned is being continued wherever the conditions are suitable.

In the central part of the City difficulty has been found in procuring the necessary sites for public substations and it is now a Council Regulation that for any building having a connected load of 150 kVA. or over supply will be given at 12,000 volts. If the consumer will provide space in which we can instal standard substation equipment, i.e. two transformers with the necessary High Tension and Low Tension Switchgear, and give us security of tenure for a period of not less than 20 years we equip the substation and give the consumer a low Tension Supply, otherwise the substation equipment is supplied by the Department at the cost of the consumer. Generally it is found that the large City consumers prefer to have substations for their own use only.

Having given a general description of the System we may now consider the safety and protective devices adopted to ensure continuity of supply and safety to the plant and operating staff. It is obvious that the completeness of the protective devices provided for any particular item of plant should depend on the proportion of the whole system which would be without supply in the event of failure of that part of the plant. For instance, protective devices which may be justified on say the Generating Main Switchboard would be quite out of place if applied to the protection of a substation on the premises of a single consumer.

BUS BAR ZONE PROTECTION :

Until a few years ago special systems of protection for the busbars of generating station switchboards had not been developed, possibly because of the difficulty in designing something satisfactory or because such protection was not considered necessary, but the extensive damage to plant and inconvenience to consumers due to interruptions of supply which have resulted from faults on generating station busbars have impressed very forcibly on the minds of engineers the necessity of providing safeguards against such failures and that the safeguards should be designed to achieve two results :—

(1) To provide that a fault occurring on the hitherto unprotected part of the electrical equipment of the Station, i.e., the busbars, and other associated parts of the main switchboard, a system of protection which would operate with the same rapidity as is usual for protective devices on other parts of the System, such generators, transformers and feeders, thereby reducing to a very large extent the possibility of a fire resulting from the fault.

(2) That in the event of a fire occurring, to have instantly available effective means of fighting the fire.

A further precaution now generally adopted for Switchboards in Generating Stations and Main Distribution Centres is to divide the switchboard into two or more parts which may be erected in

separate buildings or in one building with fire proof partitions between the two sections of the switchboard, so that a fault or fire in one section will not spread to the others. Other means of reducing fire risks are to provide means for any oil which may leak or may be blown out of the gear by explosion shall be quickly cooled and lead away from the switchgear.

For protection under heading (1) above the main switchgear of Table Bay Power Station is fitted with the Reyrolle "Leakage to frame" system, the principle of operation of which is :—

A fault on a switchboard invariably takes the form of a leakage to frame. If therefore the framework of the switchboard is insulated from structural metal work and from the metal sheathes of connecting cables, and is earthed through a current transformer leakage of current from the switchboard frame to earth provides a means of operating the protective relays which open all switches, making the faulty section dead.

To prevent inadvertent operation there are two relays in series, one energised from the current transformer in the earth connection of the switchboard frame and the other operating only in the event of an out-of-balance in phase currents of the incoming circuits. The operation of either relay gives audible or visual indication of instability.

Protection against Fire Risks :

Under heading (2) a fairly elaborate system of fire fighting equipment for dealing with a possible outbreak of fire is being installed at Table Bay Power Station. The main switchrooms are provided with automatic CO_2 plant and, as the transformers supplying the Station Auxiliaries, as well as certain coupling reactors, are located adjacent to the switchrooms, the well known "Mulsifyre" Fire Fighting Equipment, together with the usual fire barriers between units have been provided for these transformers and reactors.

The same general principles have been adopted for the protection of some of the larger substations on the Distribution System. In the Main Substations now under construction at Newlands and Molteno the H.T. Switchboard is divided into two sections, each of which is accommodated in a separate self-contained switchroom provided with fire-proof doors. The two sections forming the complete switchboard are connected by means of a cable and two section switches (one in each half). The layout of these substations is shown on Fig. 2.

In certain cases where the location of a substation above ground has not been permissible, underground substations have been constructed. In all our recent designs for such substations transformers, H.T. Switchgear and L.T. Switchgear are accommodated in separate chambers and two entrances with easy access from above are provided. An additional precaution taken is to provide means of rapidly draining away any burning oil which may be released from a fractured circuit breaker or transformer tank and leading it to a sump fitted with rubble where it can be rapidly cooled and the fire quenched. Rubble filling to a depth of 18″ consisting of 3″ to 4″ diameter pebbles is now placed round all our transformers which are installed out-of-doors. In certain older substations where transformers have been installed indoors without any provision having been made for oil drainage a brick sill some 18″ high has been built round the transformers and the sump thus formed is filled with rubble and connected to a soak-away.

The provision of special Fire Fighting Equipment is being considered for substations which are located in the basement of private buildings, e.g. under theatres and departmental stores, and at the present time six fully automatic CO_2 Equipments are on order for use in basement substations in the centre of the City.

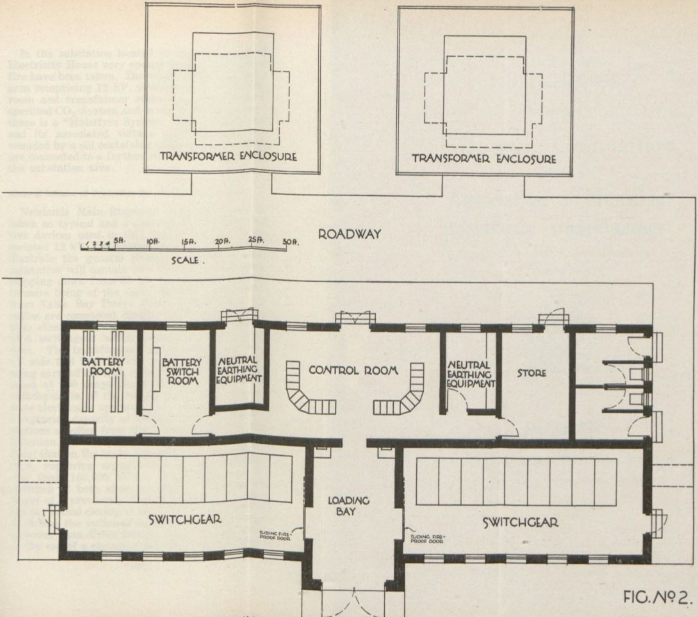


FIG. No 2.

NEWLANDS STEP DOWN SUB-STATION LAYOUT OF BUILDING & EQUIPMENT.

In the substation located in the basement of Electricity House very special precautions against fire have been taken. The whole of the substation area comprising 12 kV. switchroom, L.T. Switchroom and transformer room has a temperature operated CO_2 System and in the transformer room there is a "Mulsifyre System. Each transformer and its associated voltage regulators are surrounded by a sill containing pebbles. These sumps are connected to a further rubble filled pit outside the substation area.

General Scheme of Protection for 12 kV. Distribution :

Newlands Main Stepdown Substation may be taken as typical and a description of the protective devices used in this substation and its associated 12 kV. distribution network will serve to illustrate the general principles adopted. The substation will contain two 20 kVA transformers stepping down from 33 kV. to 12 kV. the transformers being of the same capacity as the cables from Table Bay Power Station, and the 33 kV. cables are connected directly to the transformers thus eliminating for the present at any rate 33 kVA switchgear which would be a very costly item. The transformers are connected Delta 33 kV side and Star 12 kV. side, the neutral point being earthed through a resistance of 5 ohms. and rated at 800 amps. for 5 seconds. The 12 kV. switchgear is of the totally metal-clad type, remote electrically operated from a battery and has a rupturing capacity of 350,000 kVA. In the substations supplied from the Newlands 12 kVA. distribution the switchgear is of the same general type; that on the main ring feeds being of 250,000 kVA. rupturing capacity and on the subsidiary ring feeds 150,000 kVA. Rapid closing of the switches of both sizes is obtained by using the power of a previously compressed spring to carry out the actual closing of the switch. This method of closing the switches provides a greater margin of power than direct manual operation, and allows of the use of a stronger pull off springs to give a higher speed of opening. The firing of the previously compressed spring can be done from a point remote from the switches, giving the operating staff the same protection against accidents in the unlikely event of a switch explosion as is obtained by the more expensive remote electrical operation.

Fig 3 shows the arrangement proposed for 12 kV. distribution to be fed from the Newlands stepdown Substation. Generally speaking the protection may be divided into two kinds :—

(a) What may be termed service protection which is intended to isolate in the shortest possible time any item on part of the distribution which may become faulty.

(b) A Buck-up Protection to come into operation in the event of the service protection failing to operate, or alternatively in the event of a fault occurring on a part of the system not covered by the service protection, as for instance a fault on the busbars of a substation on a ring main.

It will be seen from the diagram that the 33 kV. cables from the Power Station are dead and feeds each cable terminating directly on the H.T. winding of a main stepdown transformer. The service protection of a unit consisting of all the plant between the 33 kV. switchgear at Table Bay and the 12 kV. transformer switch at Newlands Substation is :—

At the Power Station instantaneous earth leakage which covers all the 33 kV. apparatus. On the transformer switch of the 12 kV. switchboard instantaneous balanced earth leakage which can only be operated by a fault on the 12 kV. winding of the transformer or connecting cables, thus the service protection will not operate so long as all the items of plant in the unit are sound. Inter-tripping is provided so that the whole unit is isolated in the event of either protection operating. The transformers are arranged to carry 50% of

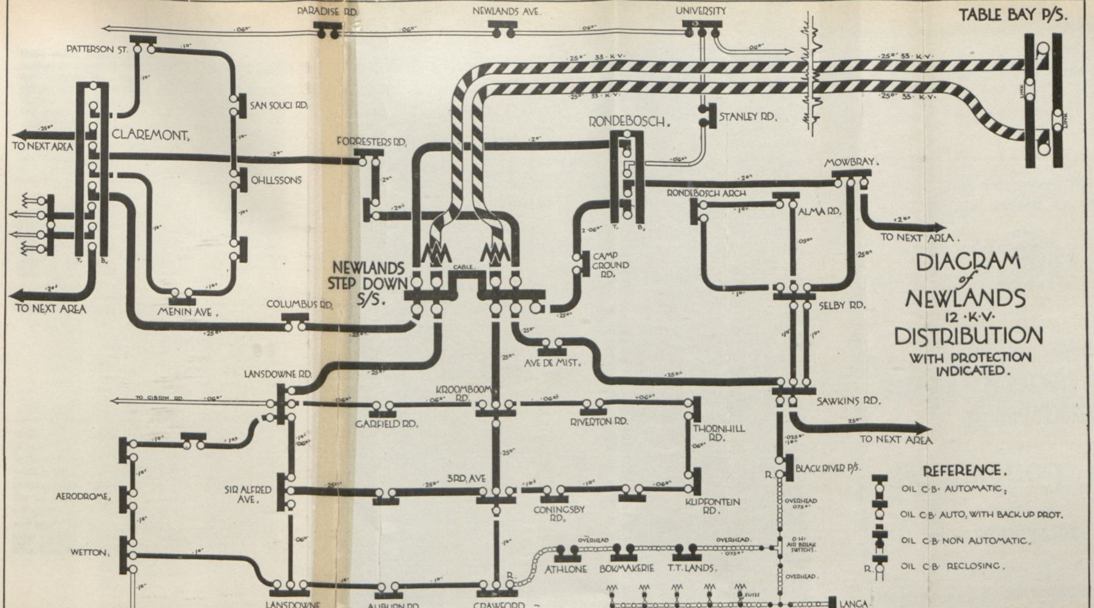


TABLE BAY P/S.
PARADISE RD.
NEWLANDS AVE.
UNIVERSITY
PATTERSON ST.
SAN SOUCI RD.
CLAREMONT.
TO NEXT AREA
FORRESTERS RD.
OHLSSONS
RONDEBOSCH.
STANLEY RD.
MOWBRAY.
RONDEBOSCH ARCH
ALMA RD.
TO NEXT AREA.
CAMP GROUND RD.
NEWLANDS STEP DOWN S/S.
CABLE.
MENIN AVE.
COLUMBUS RD.
TO NEXT AREA
SELBY RD.
AVE DE MIST.
LANSDOWNE RD.
TO GIBSON RD.
KROOMBOOM RD.
GARFIELD RD.
RIVERTON RD.
THORNHILL RD.
SAWKINS RD.
TO NEXT AREA
BLACK RIVER P/S.
AERODROME.
SIR ALFRED AVE.
3RD. AVE
CONINGSBY RD.
KLIPFONTEIN RD.
OVERHEAD
O.H. AIR BREAK SWITCHES.
WETTON.
ATHLONE
BOKMAKERIE
T.T. LANDS.
LANSDOWNE VILLAGE
AUBURN RD.
CRAWFORD
KLIPFONTEIN RD.
LANGA.
VORSTER AVE.
·25" 33·K·V·
DIAGRAM of NEWLANDS 12·K·V· DISTRIBUTION WITH PROTECTION INDICATED.
REFERENCE.
OIL C·B· AUTOMATIC.
OIL C·B· AUTO. WITH BACK UP PROT.
OIL C·B· NON AUTOMATIC.
OIL C·B· RECLOSING.

FIG. Nº 3.

their rated output as plain air-cooled units, the cooling at higher loads being done by fans blowing air through the external cooling tubes. No. oil pumps are used, circulation of oil being Thermo Syphon at all loads. The starting and stopping of the cooling fans is by means of a temperature operated relay which is also arranged to ring an alarm in the District Depot Office if the temperature exceeds a predetermined figure. In addition, the transformers are fitted with Bucholz Relays of the Two-Float Type, one float operates an alarm and the other trips the circuit breaker.

The 12 kV. network consists of a number of main ring feeders, each of which supplies several substations. The service protection of the main rings is balanced voltage Merz Price Protection which over a period of years has given excellent results. There are also subsidiary ring feeds protected in the same way.

The parts of the network not covered by the protection referred to above are :—

1. The 12 kV. busbars of the Main Stepdown Substation.
2. The 12 kV. busbars of any substation on Merz Price Ring Feeds.
3. Stub end feeds from any Merz Price ring.

The Back-up Protection should be arranged to cover all these items in such a way that in the event of it being called upon to operate, as small a proportion of the whole area shall be affected as is reasonably possible. The type of Back-up Protection adopted consists of overcurrent relays with inverse time delay having a definite minimum time for operation. Relays of this kind can be used either for overcurrent protection or as overcurrent and earth leakage with one current and minimum time for overcurrent and another setting both for time and current for earth leakage.

If we assume that faults can occur at any point on the System of sufficient magnitude to produce operation in the definite minimum time setting of the relays and that .5 secs. is required for the switch to open after the closing of the relay contacts, four or five discriminations can be obtained without exceeding a definite minimum time delay of 2.5 secs. at the Power Station. It should therefore be possible to so arrange the settings of the Back-up Protection that a fault on any of the sections mentioned will be cleared without interrupting supply to sections which are nearer the Generating Station.

On Fig. 3 there are indicated the points where Back-up Protection for the different sections of the network is provided. Taking the lower left-hand portion of the diagram, i.e. the ring main Newlands, Crawford, Wetton, Lansdowne Road, Newlands; Back-up Protection for the whole of this section is provided at Newlands. At Third Avenue, Sir Alfred Avenue, and Lansdowne Road a subsidiary ring leaves the main ring, Back-up being provided for the subsidiary ring at these points, and at Crawford an overhead line is supplied through a circuit breaker with automatic reclosing. On this section we need discrimination on the Back-up Protection in five stages from the Generating Station namely :—

1. Main Stepdown Transformers and 33 kV. Cables.
2. 12 kV. Main Transformer Switches at Newlands.
3. Circuit Breakers on outgoing main feeders at Newlands.
4. Circuit breakers on outgoing feeders at Third Avenue, Sir Alfred Avenue and Lansdowne.
5. Circuit breaker at Crawford on overhead line to Athlone.

The standard service protection for substation transformers is similar to that provided for the main stepdown transformers, i.e. earth leakage on the 12 kV. side and balanced earth leakage on the Low Tension side with intertripping between the H.T. and L.T. breakers, the Back-up Protection being over-current trip coils with time lag fuses.

For transformers some form of protection against sustained overload is required, particularly in substations with small transformers which are used in areas where the load is light, and in many cases the overhead lines are long. Several cases have occurred where a short circuit on an overhead line has been unable to pass sufficient current to clear the fault and transformers have become dangerously overheated. A similar effect would be produced by the failure of one transformer in a substation where both transformers are fully loaded. On transformers recently purchased Buchholz Relays have been fitted for this purpose which will take the place of overcurrent protection at present being used.

It is little use providing a system of protection to cause main oil circuit breakers to operate in case of faults on the plant they control unless the oil circuit breakers themselves are sufficiently robust to successfully clear any fault which may occur. Any large extension to the capacity of the Generating Plant alters the magnitude of the faults which may occur at any point on the Distribution System, and the ability of switchgear, either existing or proposed, to successfully stand up to the new conditions has to be considered de novo. This was done when the Salt River Power Station was commissioned in 1928, the result being that more robust gear was installed on all main feeders from the Power Stations.

The matter was again considered when 33 kV transmission from Salt River Power Station was commenced and once more when it was decided to build the new Table Bay Power Station. We are now satisfied that the switchgear in any substation built during the last ten years is, if kept in a proper state of repair, capable of dealing with any fault conditions which are likely to be met with now or in the future. The switchgear in some of the older substations is not sufficiently robust to stand up to the conditions which will prevail in the future and will be changed during the re-arrangement of the Distribution network when the Main Substations now under construction are brought into service, but will be used again in positions where the possible short circuit kVA. is less.

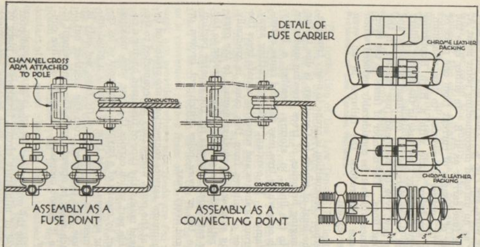
Protection of Low Tension Network :

The protection of the Low Tension Reticulation consisting of the underground feeders from substations to feeder pillars and underground cables from feeder pillars to the overhead network, and the overhead lines themselves consists of oil circuit breakers in the L.T. substation switchboards with overcurrent trips and oil dash pot time lags. The feeders are connected direct to the feeder pillar busbars and fuses are provided on each subfeeder but these are fused so heavily as to be disconnecting links only. The sub-feeders are connected solid to the overhead conductors which are fused in each direction as near the feeding point as is convenient; other fuses on the overhead network are provided where side roads are fed from the main roads. These section fuses on the overhead mains are unquestionably one of the most prolific sources of trouble on the whole System. Records kept over a number of years show that for every fuse which operates due to a fault on the lines, three fail for other reasons, mostly melting of the fuse wire due to bad contact on the fuse holder or from scaling and deterioration of the fuse wire. In any System of bare conductors exposed to the weather year in and year out bad contact at any point where the current passes from one piece of metal to another may be expected sooner or later, particularly where the conductors are run to capacity. Hot connections on the type of section fuse in use for many years compelled the writer to design a new type of fuse holder for the work, see Fig. 4. This fitting can be used either as an unfused disconnecting point as at A, or as a fuse carrier as at B. In either case the number of passages of current from one piece of metal to another is reduced to the minimum. Trials are being made with a High Rupturing Capacity Cartridge type fuse in the feeder pillars for the sub-feeders to the overhead network and in the new type of overhead fuse carrier in the overhead lines. The number of fuses on the overhead lines will then be considerably reduced which we hope will reduce the failures to an even greater extent.

Overhead reticualtion is prone to many troubles, not the least of which in Capetown is due to the overhanging branches of trees growing under or near to the lines; in stormy weather a heavy branch or a whole tree may fall and cause extensive damage. By constant effort in cutting away dangerous branches and removing unsafe trees the number of failures from this cause is gradually getting smaller, but another menace to the overhead reticulation is getting worse; I refer to the motor car which accounts for the greater portion of the 100 or more poles which get broken or damaged every year.

Consumers' service connections are protected by fuses at the point where they are connected to the overhead mains, the type of fuse used having a removable part which carries the fuse wire, making contact by means of a bayonet movement or by retaining springs. This type of fuse is a great improvement on the old type of fly fuse, not only is the fuse wire protected from the weather but it is much safer to operate as in the replacement of a fuse it is not necessary to touch any live conductor.

Inside the consumers' premises we have adopted the use of miniature circuit breakers in place of main fuses in the hope that in time consumers



FUSE CARRIER FOR L·T· OVERHEAD NETWORK.

FIG. No. 4.

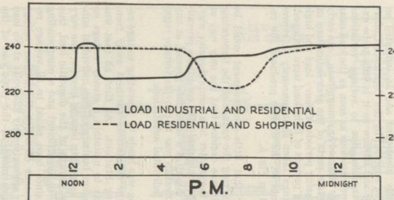
can be educated to reclose the circuit breakers instead of the Department having to send a man to renew blown fuses.

Voltage Regulation :

As previously mentioned and as indicated on Fig. 1, the area supplied by the Capetown Undertaking is long and narrow so it is only to be expected that troubles due to voltage variations would become conspicuous as soon as the load near the extremities attained any magnitude. As early as 1922 in certain parts of the area indications of low voltage during periods of heavy load and high voltage during periods of light load were obtained. Voltage readings taken simultaneously at representative points on the System produced the result indicated on Fig. 5.

It is clear that little improvement could be effected by varying the voltage at the Generating Station and it was decided that the only way of dealing with the matter in a comprehensive way, i.e., one which would deal with conditions prevailing or which might at a later date prevail, at any point on the System was to provide voltage regulation at the individual substations.

A beginning was made by providing voltage regulators at the substations furthest away from the Generating Stations. At first all that was attempted was to maintain a steady voltage on the Low Tension busbars of the individual substations, but as loading became heavier, due very largely to the growth of the domestic load, this was found to be insufficient and a compounding feature has since been added to all voltage regulators by means of which the busbar voltage increase from approximately 225 volts at No load to 240, or even more, at the peak load of the substation. The rise in voltage with the load is intended to neutralise the voltage drop on the Low Tension feeders and provide a steady voltage at each point where the overhead reticulation is fed.



VOLTAGE ON L.T. BUS BARS OF REPRESENTATIVE SUB-STN.
GENERATING STATION VOLTS CONSTANT.

FIG. Nº 5.

Fig. 6 show the effect of the voltage regulators at a typical substation. In the upper (voltage) part of the chart are shown, by a broken line, the voltage on the L.T. busbars and by a full line, the voltage on the L.T. terminals of the transformers.

The load on the substation, which is a comparatively small one, and contains two 150 kVA. transformers, is shown on the lower part of this chart. The voltage regulators in this substation and in many others are fitted with indicators to show the range of operation; 15% over a period of 24 hours is not uncommon and in a few cases the working range is more than this.

The first voltage regulators used were single phase induction type manufactured by the G.E. Co. of America. Three such units, one on each phase, are used between each transformer and the transformer switch on the L.T. Switchboard. One unit only of the three is automatically operated by means of a contact making voltmeter controlling the operating motor, the other two units being non-automatic. The three units are erected in line, the operating spindles being mechanically coupled so that all three units work together. Practically all substations have two transformers in conjunction with which six single phase regulators erected in line and all mechanically coupled are used.

The contact making voltmeters used on this type of regulator as originally installed acted direct on the operating coil of the motor switch and it was found that in certain substations an intermittent load, such as a hotel lift motor, produced a voltage variation which resulted in almost continual operation of the regulator and gave wider variation in voltage over short periods with the regulators than without them. To prevent this, time delay relays, adjustable from zero to 90 seconds, connected between the contact making voltmeter and the operating motor, are now included as standard equipment on all voltage regulators and On Load Tap Changing Transformers. The Induction type

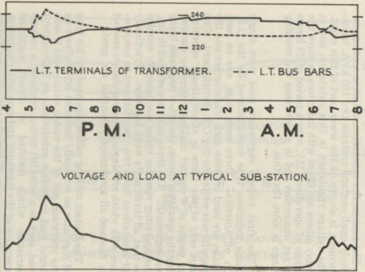

VOLTS
240
220
240
220
240
220
L.T. TERMINALS OF TRANSFORMER.
L.T. BUS BARS.
4
5
6
7
8
9
10
11
12
1
2
3
4
5
6
7
8
P. M.
A. M.
AMPERES
800
600
400
200
VOLTAGE AND LOAD AT TYPICAL SUB-STATION.

FIG. Nº 6.

of regulator has given excellent results over a period of years but it has the disadvantage that it is expensive and somewhat noisy in operation making it unsuitable for use in substations near to residential property.

A considerable number of transformer type regulators, also connected between the transformer and the L.T. transformer switches, are in use which have also given satisfactory results, but On Load Tap Changing Transformers of comparatively small size (300 kVA. and upwards) are now available and are cheaper than transformers and voltage regulators. This method of obtaining voltage regulation was first used on transformers of 300 and 500 kVA. capacity manufactured by Messrs. Ferranti Ltd. in 1929 and has been adopted for all substations built since 1933.

The inclusion of voltage regulators as part of the substation equipment added materially to the capital costs owing to the size of building required and the practice of putting transformers outside was adopted. Regular maintenance of the voltage regulators or the On Load Tap Changing transformers must be done at frequent intervals if satisfactory results are to be obtained and we have found that the maintenance of the On Load Tap Changing Gear of Outdoor type transformers is more difficult, so in some recent substations we have reverted to Indoor Installation of the transformers, but we have not yet decided whether this will be our standard practice in future.

Cable Routes from Generating Station Sites :

Perhaps one of the most important matters connected with the distribution of large amounts of electrical energy is the problem of finding suitable accommodation for the main transmission cables on and near the site of the Generating Station. Generating Station sites are never chosen for their suitability from this point of view as other considerations, such as facilities for condensing water and the supply of fuel must of necessity be given prior consideration, but as the ultimate capacity of any Generating Station site can be estimated, the number, size and direction of the main transmission cable routes can also be foreseen with a reasonable degree of accuracy. It should therefore be possible to lay out the cable arrangements for the complete Station before any cables are laid on or near the site. If, in any way possible, main cables should never be allowed to touch one another but should be separated by an appreciable thickness of incomblstible material for which purpose there is nothing better than earth. If main cables can be laid at 18″ centres in earth they can be looked upon as immune from the effects of a fault on one cable injuring adjacent cables and the intervening space can be used for auxiliary cables such as pilots.

It should be ssumed that at some time in the life of any cable it will be necessary to carry out work of some kind at any particular spot. The method of laying the cables should therefore be such that this can be done without disturbing other cables; for this reason cables following the same route should be laid approximately the same depth and under no circumstances should they be vertically above each other for any distance. Where we have H.T. and L.T. cables laid together the H.T. cables are laid a few inches deeper as an additional safeguard in distinguishing the different cables.

The ultimate capacity of the Table Bay site will be five 40/50 mVA. Generators, of which one may be regarded as spare, = 160/200 mVA. total output. Of this 50 mVA. will be absorbed by the local 12 kV. distribution from the older Dock Road site, leaving 110/150 mVA. to be exported at the Generating Station voltage, 33 kV. The main transmission lines already arranged for are :—

Route :	Number of Cables :	Capacity each :	Gross Capacity :	Nett Capacity :
Tie cables to Salt River Power Station	3	18 mVA.	54 mVA.	36 mVA.
Three Anchor Bay	2	15 mVA.	30 mVA.	15 mVA.
Gardens	3	18 mVA.	54 mVA.	36 mVA.
Newlands	3	18 mVA.	54 mVA.	36 mVA.
Total	11			123 mVA.

From these figures it would seem that the cables already provided will export the total capacity of the completed Station. If, however, we add a further two routes of two cables each there would be a total of 15 cables. Allowing 1½ ft. between cables a total width of 22½ ft. would be required, or two routes each 12 ft. wide. Anyone who has had to find suitable routes for even three large cables at 1½ ft. centres through streets already over-crowded with existing services of various kinds will realize that it is like asking for the moon to get a clear space for cables 12 ft. wide along any route in the centre of a large town. The long frontage on the Table Bay site to Dock Road and a roadway from the back of the site to Adderley Street extension provide unusually good cable facilities. From Salt River Power Station on the other hand there are only two routes available, both of which have reached a state of undesirable congestion.

Experience up to the present indicates that it may be necessary to reduce the rating of the cables given above as we find that for cables of 12 kV. working pressure and over, more faults occur on cables which are loaded to their rated capacity than on those carrying lighter loads. Most of these failures occur in joint boxes but a number have occurred in the cables themselves. In the majority of joint boxes which have given trouble the semi-liquid compound used for filling the lead sleeve is found to have migrated from the sleeve into the cable, leaving the sleeve nearly empty and collapsed. The tendency of the compound to migrate from the lead sleeves is very pronounced on the heavily loaded 12 kV. Cables and has also shown itself on joints of 33 kV. cables which have been loaded to their rated capacity. We are experimenting with a compound of a harder nature for filling the lead sleeves which it is hoped may cure this trouble and we are keeping certain joints under observation to see whether it is possible to ascertain the load at which migration occurs. So far as we can judge, the process seems to be as follows :—

The cable expands due to heat at periods of heavy load and on cooling it seems probable that the lead sheath being plastic does not contract to its original size, leaving voids in the cable which are filled or partially filled with semi-liquid compound from the joint boxes. Whether, if this process is stopped by the use of harder compound, the combined effects of voids in the cable and the vacuum resulting from the failure of the lead to follow the contraction of the other parts of the cable on cooling will have a detrimental effect on the cables in the course of time, has yet to be proved.

Location of Faults on Cables :

With a large system of underground cables at a working pressure of 33 kV. and under, faults in cables are to be expected and the location of such faults quickly and accurately is a matter of vital importance. Up till a few years ago in order to make use of any of the testing sets then available it was necessary that the resistance of a fault to earth be reduced to a very low value. This breaking down of the fault to a figure at which tests could be made was often a lengthy process requiring the use of special plant.

The development of the High Tension Testing Bridge provided an instrument which would deal with practically any high resistance fault quickly and in 1933 we purchased a set of this kind having a maximum voltage of 60 kV. to earth. This instrument has been used with excellent results for locating faults on cables of 12 and 33 kV. working pressure to the exclusion of other types of testing sets, its only disadvantage being that it requires a lot of space and a number of men to get it into position. We have recently purchased another set which is generally similar but has a maximum voltage of 15,000 and is very much easier to handle. One or other of these sets will deal with the location of any faults to which the Murray Loop Test can be applied. Occasionally faults are met with where conditions are such that Loop Tests cannot be used, in which case the Capacity Bridge Set comes in useful. It may be stated that the system of detailed cable records described later has been gradually evolved to suit the requirements of the Engineers who carry out tests for the purpose of locating faults.

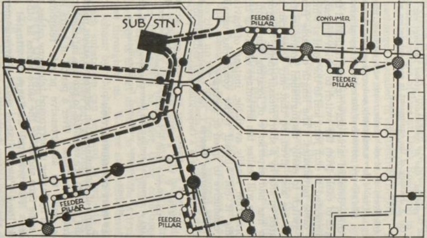
Records :

Possibly one of the most important things connected with a Distribution System of any magnitude is that satisfactory records are available. These records have to meet the diverse needs of the Operating Staff and in Capetown may be divided into diagramatic pictures of the System or any part of it, and detailed drawings of individual parts. A diagram of the H.T. Transmission and Distribution System which is as nearly geographically correct as possible, is kept at Head Office and at each District Superintendent's Office. The arrangement of this diagram is generally similar to the main diagram in the Control Engineer's Office, and great care is taken that the diagram is kept up to date and shows the conditions prevailing for the time being at any particular place. On a System which is continually being altered owing to the rapid increase in the load, a diagram of this nature is invaluable as it not only keeps the Operating Staff au fait with conditions prevailing from day to day, but in addition is used by the Distribution Engineer for the purpose of deciding the main outlines of alterations and additions which from time to time become necessary. Fig. 3 used in describing the protection of the 12 kV. network is enlarged from a section of this diagram.

All switching operations on the 33 and 12 kV. Distribution Systems are arranged in consultation with the Control Engineer. This official was appointed by the Electricity Supply Commission on the introduction of electric traction on the Suburban Railway when the Salt River Power Station was put into commission in 1928. At first he had no control of the Council's Distribution System but when parts of the Council's System were supplied from the Commission's 33 kV. feeders at Glencairn and Muizenberg he automatically became interested in certain switches on the Council's network and operations affecting these switches came under him and as larger proportions of the energy used on the Council's Distribution came from Salt River Power Station more and more switching operations were carried out in collaboration with him, until the present stage was reached.

A diagram serving a similar purpose is kept for the Low Tension Reticulation. Fig 7 shows a section of this diagram, the basis of which is a plan of the area to the scale of 200 ft. to the inch. Substations are shown in their correct geographical position. The routes of underground L.T. Feeders are approximately geographically correct as are also the position of the feeder pillars, but these are exaggerated in size so that the individual fuses or disconnecting links for the various cables leaving the pillars may be shown. The overhead mains are also shown with fuses or disconnecting points. A diagram of this type is kept in each substation for the use of the operating staff, as it not only shows the area supplied from the substation but in addition the area fed by each feeder and subfeeder and enables them to meet practically any condition which may arise by transferring load

DIAGRAM OF L·T· DISTRIBUTION FROM SUB-STATION.



UNDERGROUND FEEDERS — OVERHEAD LINES —
CABLE FEED TO OVERHEAD — SECTION FUSE —

FIG Nº 7.

from feeder to feeder, or from one substation to another in case of emergency. Other records kept are detailed drawings of :—

(a) The Overhead Reticulation on which is shown pole spacing, size of conductors, street lighting(etc.

(b) A drawing of the equipment in each substation with cable work shown in detail.

(c) Drawings of each cable route with different kinds of cable shown separately and cross sections showing the relative positions of the cables at typical points.

On these detailed cable drawings are indicated the length of cable from the switch to which the cable is connected, to each joint and to the point at which the cable terminates. The length of cable from the switch to easily distinguished points on the route are also given, so that any joint can be located on site by a short measurement. Anyone who has had experience of locating faults on a cable run will realise the advantage of having this information readily available, instead of having to dig it out himself under conditions usually not conducive to speed or accuracy.

(d) **Transformer Records :** Each transformer when delivered is given a Corporation number and particulars of the transformer are entered on a card on which is kept a detail of the life history of the transformer until it is finally disposed of.

(e) A somewhat similar life history is kept of H.T. and L.T. switchgear purchased for installation in substations.

TELEPHONE COMMUNICATION :

Means of communication between various points on the system are essential to provide satisfactory operating conditions. Over a period of years we have built up an extensive private telephone system by laying underground telephone cables at the same time and along the same routes as other cables. The principal Exchange is situated at Dock Road Power Station and by arrangement with the Post Office Authorities contains not only our own private lines but also the junction lines from the Post Office through which all incoming calls reach the Department. The concession of the G.P.O. that our private lines can be used in conjunction with the public system is very valuable and was only granted on condition that it be used on cables provided for the telephone service only. Extensions from this board are provided to all the administrative offices at Dock Road and in addition there are one or more direct lines to sub-exchanges installed in our District Depots. These sub-exchanges are usually located alongside the public telephone connections and although no wiring is inter-connected with the Public System at these sub-exchanges the same operator is able to handle all calls. There are direct lines from these sub-exchanges to each of our substations, except in a few cases where the cost of picking up a substation cannot be justified. The residences of senior officials are also connected to the System. Each substation therefore provides a point from which any employee can get in touch with the Depot or Head Office.

It is standard practice for employees dealing with consumers' reports of interruptions to supply to ring up the Depot from the nearest substation for further instructions after completing a report.

The Private Telephone System has proved to be exceedingly valuable in the event of serious trouble on the System as under these conditions the Operating Staff find that the public telephone service is almost useless as everyone is trying to get through to us. We are at present developing a scheme by which the private telephone wires to each substation can be used to indicate at the Depot Office when any abnormal conditions exist, such as the operation of any of the circuit breakers.

STREET LIGHTING CONTROL :

To arrange a satisfactory method of switching on all streets lights in an area as big as the City of Capetown is a matter of some difficulty as the number of switching points must be large. Control points are in almost all cases located in substations and generally we try to arrange that the street lighting area and general supply area of any substation shall be the same. The standard street lighting equipment of a substation is a motor operated 3-phase oil circuit breaker arranged to reclose three times and then remain open in case of a fault. In the substation there is also a link on each phase wire so that if one phase of the street lighting becomes faulty the link can be removed and the supply to the sound phases restored. Hand switching is out of the question as even with motor transport there would be too much spread in the switching time. As far as possible, street lighting control is centralised at Depots. All the 3-core pilot cables used for Merz Price protection of the 12 kV. feeders have three pairs of telephone wires built into them. Our arrangement with the G.P.O. by which our Telephone System can be used on the Public Telephone System precludes us from using these wires for telephone purposes, but they have been largely used for street lighting control. There are also in various parts of the area a number of small multicore cables which once formed part of the supply system but became redundant during changeover to the 12 kV. Distribution. When the route of such cables is suitable they have also been used for this purpose. Several substations are controlled as one unit, the completion of the switching operation in all substations gives an indication back to the control point that the operation has been satisfactorily carried out. Switching off is done in the same way and again the indication of the successful completion of the operation is given at the control point. The operation of the street lighting switch at any substation in one of these units, due to fault conditions, does not affect the other substations.

Other methods of control of street lighting in use are light sensitive controllers, time clock operated switches and in a few cases the closing circuit of the street lighting circuit breaker in a substation may be connected directly to the street lighting supply wire from an adjacent area. None of these methods, however, possess the reliability of the unit control system described above.

The finding and replacement of lamps, which burn out or fail for any other reason, quickly and at reasonable cost is a matter which presents many difficulties and if not done promptly gives the public a bad impression.

Up till quite recently no regular system of inspection and replacement was in vogue but lately every lamp is inspected at least once a week and the lamps in the principal streets and traffic arteries are inspected nightly. For this work the staff and transport which deal with consumers' complaints of "no supply" are used during the slack periods from about 9.30 p.m. until early morning.

SERVICE TO CONSUMERS :

The multiplication of the uses of electricity, particularly in private homes, makes it necessary to consider how far the Supply Authority should give attention to interruptions of supply due to causes on the consumer's side of the meters and main fuses or circuit breakers. The average consumer does not and cannot be expected to know the cause of any failure of supply, and naturally gets in touch with the Supply Authority. Questioning, the consumer might or might not elicit sufficient information to decide whether the trouble was on his side of the meters or not, but it would certainly leave him with a feeling of irritation. We have therefore adopted the policy of sending a man to investigate any report as quickly as possible, and generally to give the consumer the impression that we wish not only to sell him electricity but service as well.

Quite 50% of the reports received are found to refer to failures on the consumers' side of our meters, and report men are allowed to replace consumers' main and circuit fuses. In the event of a circuit being faulty it is left "dead" and the consumer is requested to get a contractor to attend to it. There is little doubt that many simple repairs, such as faulty flexibles, are carried out by the report men and occasionally it is brought to our notice that larger repairs are attempted and payment asked for. Any case of this kind brought to our notice is treated with the utmost severity and we make sure that all report men hear of the treatment meted out to the delinquent. No charge is made to consumers for attending to private fuses; it costs us practically nothing as we have to have men available in any case, and the service rendered earns a certain amount of goodwill for the Department. No doubt our leniency in the matter is taken advantage of by some consumers, and possibly some wiring contractors feel that this work should be left to them. On the other hand, the convenience of the consumer must be considered first, having sent a man to see what is wrong it would be worse than foolish to leave the consumer without supply until he could get a contractor to send someone to do less than five minutes' work.

DENSITY OF LOADING :

The domestic load has been developed to such an extent that it now represents considerably more than 50% of the total. In the last three months for which figures are available, the quarter ending June 1938, the units under the Domestic Rate were 33.94 million out of a total of 56.06 million = 60.4%. The demand per consumer and the density of load in residential areas to-day gives figures which a few years ago would have been considered nearly, if not quite, impossible of attainment. For example, the consumers in a purely residential area fed by one feeder from a substation were counted, the total being 70. The load on the feeder at the time of peak load was 236 amps. 3-phase giving an average load per consumer of 10.1 amps. at 220 volts. It is outside the scope of these notes to consider the causes of the rapid development of the domestic load but three contributory causes may be mentioned in passing, namely low charges for electricity, an attractive scheme for hire-purchasing apparatus to consumers, and climatic conditions which accentuate the inherent advantages of electricity for domestic heating and cooking.

To obtain the density of load in representative districts, the area fed by each of a number of substations was calculated, the result being given below :—

NAME :	Area in Sq. Miles :	kVA at Peak Load :	kVA per Sq. Mile :
1. Atlantic Road ..	0.081	700	8,600
2. Round Church ..	0.116	940	8,200
3. Virginia Avenue ..	0.111	912	8,200
4. Canterbury St. ..	0.09	720	8,000
5. Hall Road ..	0.108	870	8,000
6. Collingwood Rd. ..	0.11	615	5,600
7. Plein St. W'stock	0.19	905	4,760
8. Stegman Road ..	0.23	840	3,650
9. Alma Road .	0.17	575	3,400
10. Eden Road ..	0.28	900	3,200
11. Maynard Road ..	0.27	810	3,000
12. Stellenberg Av. ..	0.25	730	2,900
13. Gibson Road ..	0.29	740	2,540
14. Pinelands ..	0.19	413	2,200

All the substations having a loading in the vicinity of 8,000 kVA. per square mile are either residential areas with a number of hotels and large blocks of flats or have combined residential and factory loads, the peak load of which occurs at about 6 to 6.30 p.m. on week days in the winter.

In a large number of substations with a purely domestic load the heaviest load is between 11 a.m. and 12.30 p.m. on Sunday. The figures for Collingwood Road and Pinelands are especially interesting, the former has a combined factory and residential load, but as the peak occurs on Sundays when the factories are shut down the figure is a measure of the domestic load only. The houses in the vicinity are built on small plots and are occupied principally by people of the artisan class. Pinelands is a comparatively new suburb with the same general class of resident but the plots are larger and the roads wider. Both areas are almost fully built up but notwithstanding the portion of the Collingwood Road area occupied by the factories, the loading per square mile is more than double that of the newer suburb.

Having reached such an advanced stage in the development of the domestic load one is inclined to ask whether saturation has been reached or is in sight. This is a question which has been asked for many years; as long ago as 1911 I remember the Deputy Treasurer of the English town where I was then employed by the Electricity Department, expressing the opinion that the Electricity Department could not hope to expand for many years at the same rate as for the last few years, as "saturation would be reached." Naturally I disagreed with him and I am still of the opinion that saturation in the use of electricity is unlikely to occur for many years to come. By the time every possible consumer has been induced to use all the current consuming devices now available, other uses of electricity will have come into general use; to mention only one, namely air conditioning, this as yet does not represent much load but within the next few years it will I think double the load in the business part of the City, and may in the future represent a considerable increase in the factory and domestic loads.

CHANGEOVER :

No description of Capetown Distribution System would be complete without some reference to the standardisation of supply which has been in progress since 1921. At that time the only things which were standard throughout the area of supply were 220 volts for lighting supplies and the frequency of any Alternating Current 50 cycles per second. There were large areas with Direct Current Supplies at 440/220 volts, other areas with

2-phase Alternating Current Supplies 5-wire, 220-volts from neutral to each phase wire and 440 volts across phases, and still other districts with a 2-phase 3-wire supply 220 volts between phase and neutral and 310 volts across phases. The overhead reticulation covering many miles of route had to be entirely rebuilt as the changeover was carried out. In several parts of the City there were also non-standard H.T. underground distribution systems, 3,300 volts 3-phase in Muizenberg and Wyneberg, 2,200 3-phase in Maitland and 2,200 volts 2-phase in Sea Point and the Gardens districts. With the exception of four consumers who have 2-phase supply, all our consumers now have a standard 380/220 volt connection but we still have a few substations giving the standard L.T. supply from the old 2,200 volt 2-phase distribution.

As far as D.C. is concerned, there are still about 140 consumers, everyone of whom has also a standard L.T. A.C. supply available. The greater part of the D.C. load is represented by lifts. Owing to the cost of converting lifts from D.C. to A.C., many years ago we adopted the policy of leaving lifts on D.C. when changing the general supply to any building. The maintenance of lifts in this district is almost invariably carried out by the suppliers. These firms are aware that the Council is willing to contribute towards the cost of converting a lift to A.C., consequently if the electrical part of any lift becomes expensive to maintain they persuade the owner that it is to his advantage to obtain the contribution from the Council and to change his lift to A.C. The great advantage of this scheme is that beyond the contribution towards the cost of converting the lift, the Council has no responsibility in the matter. From 12 to 15 lifts are converted in this way every year and until all the other D.C. consumers have disappeared we shall continue this procedure.

For ordinary changeover the procedure is as follows :—

An inventory of the consumer's D.C. apparatus is taken and prices obtained for A.C. apparatus to reproduce existing conditions, details of what will reproduce existing conditions being agreed with the consumer, and a new A.C. service connection is run into the building. The consumer undertakes at his own cost any alterations which may be necessary to the wiring of the building and places the new apparatus in position and connects it up.

It usually happens that during the changeover a consumer wishes to obtain something different to what he already has, in the case of a wireless set probably he wants something more elaborate and in the case of motors he probably needs machines of different size. In such cases we meet his wishes so far as can be done without additional cost to the Department; for motors he may have whatever size of machine he likes provided that the total horsepower and total number of new machines does not exceed what he already has and that the machines are of the same general type. For Wireless Sets and other similar apparatus a more expensive unit may be obtained by paying the difference in cost. The consumer almost invariably gets a definite advantage from the changeover, in addition to which a lower price is now charged for A.C. Power Supplies than for D.C. During the very extensive changeover which has been carried out we have had very few cases where consumers have been dissatisfied with the results.

For the last ten years we have been in a position to supply A.C. current to any consumer and have always been willing to give an A.C. supply to which new apparatus could be connected if it were inconvenient for the consumer to undertake the changeover of existing apparatus for the time being. In some cases recovered D.C. apparatus has been loaned to other consumers to avoid the purchase of new D.C. apparatus. Advertisements have been inserted in the public press warning consumers not to connect up any apparatus without first notifying the Department.

We were fortunate in commencing the standardisation of the System at a time of considerable industrial development; for practically the whole of which the standard supply was made available. This, together with a willingness to loan motors in the comparatively small number of cases where extension had to be made on the old non-standard system, made the changeover simpler. We were also fortunate in having standard supply available in all residential areas by the time mains-operated Wireless Sets became common.

In conclusion I desire to record my thanks to the City Electrical Engineer for his permission to use official staff and records in compiling these notes and to various members of my staff for their assistance in the matter, particularly Mr. E. G. Ivey, Substation Engineer, and Mr. T. Russell, Mains Records Draughtsman.

The President: You have already signified by your applause your great appreciation of the paper read by Mr. Stubbs, into which he has put a good deal of work. This is undoubtedly one of the most interesting papers we have had, the discussion on which will be taken after the adjournment.

The Convention then adjourned for refreshments, and resumed at 11.40:

"EARTHING IN RELATION TO L.T. SUPPLY."

The President: We have on the agenda also a discussion which may be taken now with that on Mr. Stubbs' paper on the paper on "Earthing," read by Mr. Kinsman, of Durban, at the last Convention. Mr. Kinsman has handed to the Secretary a few notes which he asks to be read.

The Secretary then read the following notes by Mr. Kinsman:—

NOTES ON THE SUBJECT OF EARTHING IN RELATION TO LOW TENSION SUPPLIES OF ELECTRICITY.

By C. KINSMAN, Assistant City Electrical Engineer, Durban.

Shortly after the publication of the Proceedings of the last Convention, the writer received a letter from one of the Engineers on the staff of the Electricity Supply Department of a large Australian City, expressing interest in the paper on "Earthing." An interchange of views followed, from which it was evident that the impossibility of securing consistently low resistance "earths," in the absence of metallic water pipes, was a very pressing problem in that City. So seriously was it viewed that the City Council has sent two of its Engineers to Europe to study British and Continental methods of achieving protection in similar circumstances.

Since presenting the paper, the writer has had the opportunity of installing, in a small rural area, protective multiple earthing of the neutral combined with earth leakage switches. The time, during which the system has been in operation, is too short for any conclusions to be arrived at.

A draft British Standard Specification for earth leakage switches has been compiled and circulated; from this it may be assumed that there is an increasing demand for this type of apparatus. As pointed out by the writer in his paper, earth leakage protection affords very sensitive and efficient means of isolation in the event of an appreciable potential being acquired by accessible metal work, but at the same time, causes unduly extensive interruptions in the supply.

The writer has nothing further to add to the subject matter of his paper, but expresses the hope that any discussion may be producive of much which will assist those responsible for low tension supply.

Mr. Swingler (Communicated): I think that it will be agreed that the automatic disconnection of supply to an apuliance that has developed an electric fault with a minimum of interference of the supply to other appliances is one of the most difficult problems that electrical technicians are called upon to solve. The difficulty both from the technical and economic standpoint is all the greater in connection with supplies to low tension "weak" current appliances such as those most commonly used in dwellings and as this type of appliance is handled by a larger number of persons than any other type of electrical appartus the risk—expressed as a numerical proportion of the risk of shock from electrical appliances in general—is the greatest with them. The problem is, therefore, one which calls for the closest study.

In the past the general panacea for all such troubles was confidently believed to lie merely in earthing the non-current carrying parts, but as we all know this has on occasions been proved in practice to be unreliable for several reasons, one of the most important being the difficulty in many instances of ensuring that the earth plate or the equivalent is making a sufficiently low contact resistance with the general body of the earth to ensure the blowing of a fuse in the faulty circuit.

Mr. Kinsman's comment to the effect that the multiple earthing system of providing for the disconnection of a faulty circuit by the blowing of a fuse is now being adopted extensively in a number of countries should be read in the light of the fact that on the other hand the use of protective earth leakage switches is also being adopted in a number of countries in which multiple neutral earthing is allowed only under special conditions and circumstances. That the latter cannot be relied upon in some cases is illustrated by the fact, for example, that it is not unusual to find a resistance of the order of 100 ohms between a hotplate and the frame of an electric range in which case even with the frame connected to the neutral of the supply this method gives no protection whatever against the risk of shock being sustained by a person handling a utensil on the hotplate.

The widely divergent views on the solution of the problem indicate either the existence of correspondingly widely differing conditions in the places concerned or a realisation that further experience is required by those who are interesting themselves in this matter to determine which is to be preferred from considerations of working conditions. I am inclined to the view that the explanation lies in doubt as to which is the best arising from lack of experience and I suggest that one should treat with caution claims made by the proponents of each of these methods until one has tried them out in practice. Fortunately, this is a matter on which practical experience can readily be obtained by any undertaking and with the object of determining the efficacy of earth leakage protective switches under local conditions experiments are now being made in Capetown with the use of switches of a type conforming to the requirements of the State Electricity Supply Commission of Victoria which are used extensively in Municipal Undertakings in Melbourne, Sydney and elsewhere in Australia. The results of the experiments will, however, not be available in time for publication in these Proceedings but will be made available to the Association at a later date.

Briefly the system is one in which a protective earth leakage switch is used in addition to protection by means of direct earthing, the earth leakage switch being equipped with a separate earth electrode, the resistance to earth of which must not exceed 200 ohms. Thus in the event of a fault occurring which does not bring about disconnection of the circuit by causing a fuse to blow the earth leakage switch will disconnect the supply. They are designed to operate whenever the pressure on that part of the installation which they protect rises to 26 volts above earth.

DISCUSSION ON MR. STUBBS' PAPER.

The President: The Paper by Mr. Stubbs is now open for discussion.

Mr. Milton (E.S.C.): May I congratulate Mr. Stubbs on the very excellent paper which he has presented to us. There are possibly some members present who have in mind that the subject matter could not be applied in the average town in the Union.

All distribution networks, however small, must necessarily be planned for the future, and for planning to be effective, a knowledge of the requirements of future design is essential. In this respect the experience gained in the larger Municipalities is of very great assistance.

I was pleased to observe that the author touched on the question of the necessity for a cheap and abundant supply of electricity and quoted the Electricity Act as a national guide in this respect. This is an aspect which I have often striven to drive home in discussions with gentlemen closely concerned with the Municipal aspect of electricity supply, and it is surprising how many regard the Electricity Department merely as a goose that lays golden eggs instead of an essential service which is judged by users on the cost of that service to themselves. The usual argument brought forward is that had the the Government intended Municipalities to operate their electricity undertakings at cost, provision for this would have been included in the

Electricity Act. It is not possible to reply conclusively to such an argument but the probable reason for the omission should be obvious.

I am glad that the author has expressed his views on the question of the necessity of adequate rupturing capacity in all switchgear. This is an aspect which is frequently lost sight of in the design and layout of electricity reticulation systems. Of course, it is not economical in many of the smaller Municipalities to provide switchgear to meet possible conditions very far ahead, but there is a grain of comfort in the fact that switchgear displaced from the power station can be moved outwards along the network from time to time, intervening impedances making it possible to use switchgear for a long period on the system though not continuously at the same point.

As regards the protection of low tension networks, the author has told us that trials are being made with a high rupturing capacity cartridge type fuse in the feeder pillars, and I am sure that this Association would be pleased if it could be supplied with the results of the trials.

This remark also applies to the section of the paper dealing with the compound for joint boxes. Information as to the results of trials of this nature is always invaluable to the Engineer in charge of an undertaking.

In a paper which is to be delivered on Friday by my friend, Mr. Sparks, we will find mention of the house service fuses and the author's advice to-day in regard to the adoption of miniature circuit breakers in place of main fuses should be recalled then.

The question of voltage regulation which the author has dealt with, is one of vital interest to consumers and worthy of much more consideration than it receives in many cases. From time to time devices have been patented and in some cases effectively brought on the market for regulating the voltage of supply at points in a network. These devices have usually proved too expensive for general application, but I understand that quite recently satisfactory and cheap apparatus has been made available commercially at prices which should appeal to the distribution engineer. It might be of service to us, Mr. President, if you would permit our commercial friends present to speak on this point.

Under the heading of "Street Lighting," the author has dealt with the question of lamp burn-outs, and states that a regular system of inspection and replacement is now in vogue, the lamps in traffic arteries and principal streets being inspected nightly and the remainder at least once a week. This should result in information being obtained as to the reliable number of burning hours of the various types and sizes of lamps used, and should also provide reliable information on the cost of maintenance of this service. Possibly the author would be permitted to disclose such information, which would, I am sure, be welcomed by all. In this connection I recall that Mr. Littlewood, at the Maritzburg Convention, suggested that lamps should be used on the basis of a total number of burning hours at the end of which all lamps should be replaced irrespective of whether or not they were burnt out. Possibly the experience gained in this City may throw some light on the probabilities of Mr. Littlewood's suggestion from the point of view of its soundness.

As regards the replacement of consumers' fuses, it was pleasing to observe that the undertaking is willing to replace consumers' service fuses free of charge if it is found as a result of an emergency call that the service fuses and not main fuses which have failed. It seems to me this might result in abuse. That it is a special privilege not intended to prejudice the normal business of the contractors is certainly brought out by the force-ful exposition of the treatment meted out to members of the staff tempted into doing too much!

As regards the three contributing causes underlying the rapid development of the domestic load, I feel that in fairnss to others a fourth associated cause **should have been** mentioned in connection with the charges for electricity, namely the " geographical position," which always affects the cost of electricity's competitors, i.e., when referring to low charges the term " low " is very definitely relative.

When dealing with the density of load the author refers to the districts of Collingwood Road and Pinelands as being especially interesting. The nature of the " special interest " was mentioned in the author's review and might well be included in the journal. Whilst there are many more points of particular interest in the paper in addition to those I have mentioned, I feel that I have taken up considerable time. I thank you, Mr. President.

The President: I should like to make it quite clear that the commercial friends to whom Mr. Milton referred are very welcome to take part in the discussion.

Mr. Rodwell: In thanking the author for his paper it can be truly stated that the engineers of the Capetown Electricity Department are to be congratulated on the care which has been exercised in the selection of protective equipment. That such equipment has justified itself is borne out by the remarkably low total annual consumer hour loss of 0.4.

Dealing first with the question of busbar zone protection, it is very interesting to note that the engineers had sufficient courage to adopt a form of protection which while excellent in theory has been the subject of a great deal of controversy.

This must be one of the first, if not the first, installations of busbar zone protection in the Union, and it would be of great interest to all engineers to hear the author's experience with the installation.

At the time extensions to Johannesburg's electrical undertaking were contemplated the question of busbar zone protection was considered in relation to the proposed 20k.V. switchgear installations in substations. It was felt at the time that too little experience had been gained, either in Britain or in this country, with such forms of protection. The whole question was, therefore, left in abeyance until such time as either experience had proved existing forms to be reliable or better systems had been developed.

The Capetown Electricity Department is obviously keeping abreast of modern practice for their protection against fire risks leaves nothing to be desired. The whole question of fire protection is, to-day, receiving the attention of all engineers and quite rightly, too, since the damage caused by a great many of the disastrous fires which have occurred in the past could have been greatly minimised had such precautions been observed.

The system of distribution adopted by the Johannesburg Undertaking resembles that of Capetown, if one substitutes 20k.V. and 6.6k.V. for 33k.V. and 12k.V. respectively. The step-down transformers, directly coupled to 20k.V. cables without high tension switching, are star-interconnected-star in the case of Johannesburg.

It is very interesting to note, therefore, that the system of protection for the two systems is identical, viz., earth leakage at the sending end of the 20k.V. -feeds and balanced (or restricted) earth leakage on the L.T. sides of the step-down transformers with intertripping.

With regard to the protection of secondary feedrs, i.e., 12k.V. in the case of Capetown and 6.6k.V. in the case of Johannesburg. Capetown is more fortunate in that such feeders lend themselves to balanced protective schemes.

Another item of great interest is the extension of the application of the Buchholz Relays to cover sustained high resistance faults on the L.T. side of transformers, where ordinary overload protection has not proved satisfactory, I am sure all engineers will be interested to hear whether or not such cases can be successfully handled by Buchholz Relays.

I should like to endorse the author's remarks on the importance of ensuring that the rupturing capacity of circuit breakers is adequate to the task they have to perform. Johannesburg has been very unfortunate in this respect in that the growth of generating and feeder capacity has been phenomenal, necessitating the frequent revision of circuit breaker sizes. A new system of feeding sections in the central area, close to the Power Station, is being inaugurated entailing feeding certain zones through reactors which limit the maximum possible short circuit k.V.A. to 250,000.

A great deal of trouble has been experienced in this area in the past, as a result of circuit breakers and their associated current transformers in the high tension consumer's premises being too small to cope with faults developing on the high tension sides of their installations.

The author is to be congratulated on his choice of a subject of such vital interest and the excellent way in which he has presented it in his paper.

Mr. C. N. Berry (South African Lamps Association): During the last few years it became apparent that the uniformity in life performance of Association Lamps was sufficient to enable lamps to be replaced after a definite number of burning hours without the risk of, on the one hand undue waste of lamps or on the other hand an execssive number of failures before the agreed burning life had been reached.

It was apparent that street-lighting authorities controlling street-lighting installations which covered many miles of streets could economise in the labour of replacing of lamps if the lamps in one street were replaced all at once and replaced during the hours of daylight instead of as and when they failed at night.

An investigation of the various items of cost included in the cost of operating a street-lighting installation showed that somewhere about the following facts were correct:—

(a) 40.5 per cent. of the expenditure was required for labour of maintenance.
(b) 38.5 per cent. of the expenditure required for electrical energy supplied to the lamps.
(c) 15 per cent. of the expenditure was required for management and other incidental expenses, and
(d) Only **6 per cent**. was actually expended on lamps.

It was, therefore, obvious that a saving on labour required for maintenance was much more important than a small extra consumption of lamps.

Having regard to all these facts, proposals were made to various central station Engineers that they should establish a regular programme throughout the year for replacing a certain number of lamps each day or each week, which programme would include the replacing of the whole of the lamps throughout the year as required.

It was found that for the ordinary installation a replacement at somewhere about 1,000 hours' burning gave a workable arrangement and a certain number of street-lighting authorities have adopted this system and have found that they do in fact save in the number of men required for replacing lamps and that they do not buy appreciably more lamps than they did before when they replaced each lamp as and when it failed.

Another advantage of this system is that the number of lamps which burn out in service is reduced. Obviously, the lamps which are replaced before they burn out never fail in service at all. In some towns this advantage is the one which has most appealed to the Engineer.

It has also been found, as was to be expected, that the removal of the lamps after 1,000 hours' or 1,100 hours' burning results in the quality of the street-lighting being higher than it is where lamps are allowed to burn until they burn out.

It has been found that street-lighting authorities who adopt this system are unwilling to even experiment with lamps of more consistent or uniform output in the fear that in so doing they will get lamps of inferior uniformity which will interfere with the working of their replacement scheme.

The actual hours after which lamps are replaced varies from town to town. For example, on the Thames Embankment ,which is an extremely important thoroughfare, the lamps are replaced after 800 hours' burning. In some towns of less importance it is found that 1,100 hours is sufficiently early to replace. Naturally, in the latter case, there are a larger number of actual burnouts during the evening.

Finally, it is found that the replacing of the lamps in groups can also be made the occasion for cleaning the fittings and generally tidying up the installation.

The number of street-lighting authorities in Great Britain who are taking advantage of this scheme is steadily growing but the idea is so new that naturally it has not received very wide adoption yet.

Mr. A. Rossler (Cradock): The author has provided us with a very interesting resume of the distribution system of the City of Capetown. It is an excellent treatise which should be of great value to the smaller towns. I personally have gained a great deal of information from the paper.

I notice under "System of Supply" that each low tension feeder and each sub-feeder supplies an isolated section. It would be interesting to know whether the City of Capetown has ever considered adopting a low voltage grid whereby the low tension distribution network is inter-connected either solidly or through high capacity time fuses. If such a scheme were feasible the inter-connection would lead to reductions in transformer K.W.A. There would, in addition, be a reduction in the copper losses as a result of the more even loading of the cables, and, in summer, the excitation losses could be reduced by disconnecting redundant transformers.

In connection with the Reyrolle "leakage to frame" system of protection, I would be glad if the author could advise how the framework of the switchboard, which must be fairly heavy for the larger breaking capacities, is insulated from structural metal work and from the metal sheathes of connecting cables.

Quite a number of Undertakings appear to have trouble with overhanging branches of trees growing near overhead lines. So did we in Cradock until some trees, after a violent storm, damaged private property. After the court case, which was decided against the Council the trees had to be removed immediately, or, alternatively, trimmed and lopped to a height of 16 feet. I again wish to thank Mr. Stubbs for his most interesting paper. (Applause.)

Mr. Gyles: You will remember that at the Maritzburg Convention Mr. Littlewood spoke of the replacement of street lamps in any one year after a burning period of about 800 hours. In Durban, as an experiment, we put in all new lamps in one area some miles out of town. Within about 14 days several had failed, necessitating the sending of a man out to make replacements. I think we all recognise that one of the biggest expenses of street-lighting is the labour costs.

Mr. Clinton (Salisbury): The paper presented by Mr. Stubbs has come opportunely, for the reason that in almost every town an intensive development of domestic load is taking place. With this has come a series of problems common to most undertakings. The methods for meeting these difficulties are, therefore, of paramount importance, and on this account the exhaustive survey given the Association by the author, from the generating staation to the consumer, is certain to be of great value to the Association and its members. I propose to deal with three or four points arising from the paper.

In Salisbury we were faced with a reconstruction of the distribution, having in view the potential demands of domestic consumers. This meant, firstly, a decision on the most economic size of transforming substation for L.T. supplies and its consequent area for supply. In this problem it soon became apparent that the first decision was to selected a suitable percentage variation from the declared pressure of supply. Mr. Stubbs has fittingly stated, early in his survey, that this aim can be regarded as the first essential of any supply. In Salisbury a decision was made to aim for plus or minus 2½ per cent. from the declared pressure, and in this connection a somewhat amusing incident brought strongly to my notice the wide-awake public with which one has to deal.

A prominent Government official, keen on perfect wireless reception, had become disturbed at the effect on his results variations in supply voltage caused. We were soon in receipt of a complaint which on investigation showed that a variation of 5 per cent. was being experienced. Whilst then of the opinion that this was not unusual I was unable to convince the consumer who next complained to the Chairman of the Electricity Supply Commission in Rhodesia, and on receiving a like assurance, next sought the assistance of that august body, the B.B.C., from whom he received like advice on the only commercial solution available. It does, however, go to show how important it is to improve on the usual statutory limits allowed an undertaker of electricity. On the basis of 2½ per cent. variation the local considerations soon gave an economic size and area for each sub-station. Even so, it was found impossible to maintain by means, other than the installation of automatic on load tap changing transformers, adequate voltage regulation within these limits of 2½ per cent. Though this naturally involved a considerable outlay in capital expenditure, it was found on further examination that the losses saved and the additional revenue earned by maintaining these standards almost covered the loan charges on the capital required for automatic on load tap changing equipment.

My next point is inspired by the author's inference regarding the use of the word "cheap" in conjunction with the obligations of an efficient supply; likewse by the references in Mr. Eastman's address I feel every engineer would like to see the true implication of the word "cheap" taught in kindergarten schools and yearly thereafter. Its inevitable nasty results are true in electrical supply as in other spheres. But the word " cheap " applies both to the standard of the supply and the tariffs governing it. Too low a tariff may leave no margin, and a " cheap " standard of service fail to give the service which is obligatory on all undertakings of electricity. This point was stressed by Mr. Eastman in his presidential address. It, therefore, behoves all of us to avoid the pitfall of reducing tariffs to the bone, only to find ourselves faced later with capital outlay and consequent annual loan charges which can barely be met.

Finally, I wish to raise a somewhat revolutionary or at any rate a controversial point arising from the remarks by Mr. Stubbs in that portion of his paper dealing with the area of supply. Here it was stated that certain areas supplied were barely payable propositions. Mr. President, I think it will be agreed we are all operating electricity undertakings as public utilities and not as trading concerns. The obligations we, therefore, assume are to every postential consumer within our respective authorised areas of supply and not merely the direct ratepayer. This obligation is to make a supply available to every potential consumer, whether urban, suburban or rural. As I interpret our responsibilities in this matter the profit and loss account for extending a supply to each individual consumer should not decide his eligibility for supply but rather the average cost of giving supply to all over the whole area of supply. Our potential rural consumers are with the urban and suburban consumers, part of an economic unit about a centre of gravity but all with inter-dependent relations and responsibilities. It is impossible to separate them, and, moreover, unwise. This may smack of communal legislation but is, I feel, the directions in which we should aim.

The average cost and a uniform tariff over the whole area of supply is the truer reflection of our duty. In this connection I was struck whilst overseas by the fact that many commercial products are now being retailed at a standard price, irrespective of the places and distance from the source of manufacture. Is this not an indication for us? In Salisbury, I am glad to say, my Council is shouldering its responsibilities in this respect, if only for the moment in an indirect manner. Of the revenue account surplus, up to 70 per cent. is expended on schemes of rural development involving capital expenditure that could not otherwise be considered remunerative. This, I hope, will be a policy for improvement upon in the future. I thank you, Mr. President.

Mr. Pirie (Bloemfontein): I would like to ask Mr. Stubbs whether there are any definite reasons for Capetown having their public lighting mains above the power mains. It has been my experience that greater advantages accrue from street-lighting mains being placed underneath the power lines. The cascade system of control of public lighting is adopted in Bloemfontein.

I should also like to know what conditions are agreed to by the Electricity Department of Capetown, or, for that matter, any other centre, when it is found necessary to ask the consumer to provide suitable accommodation for a transformer and swtchgear in a block of flats? Is rental paid, or only a nominal peppercorn rent paid to prevent the Municipality acquiring "rights of prescription?" Further, does the Department utilise the accommodation provided for supplying low tension current to surrounding consumers.

I have great pleasure in congratulatng Mr. Stubbs upon his excellent paper.

Mr. Stevens (Ladysmith): I should like to express my appreciation of Mr. Stubbs' contribution to this Convention.

There are, I am sure, many here who would like to know Capetown's reasons for adopting, as a standard, four wire services to consumers. Four wire installations are more costly to the consumer and must in consequence account for the delay in some cases in the installing of electric light and appliances. The cost of such service connections and metering arrangements is considerably greater to the supply authority.

If the choice of two and three phase connections is with the idea of improving the balancing of the supply system, I do not think there is much to be gained over single phase connections balanced one against the other. It may be with the idea of reducing the size of service and stove fuses, but with the adoption of high rupturing capacity non-deteriorating cartridge fuses large currents can very easily be looked after. Of course, two and three wire supplies assure that a partial supply is available even though there is a fault on part of the installation or stove. But with such a finely organised system as you have in Capetown there should be no need for a consumer to be without current for very long in the event of a fault.

REPLY BY MR. STUBBS.

I will refer to the various points raised.

Bus Zone Protection: There was no difficulty about arranging for the insulation of the switchboard standards. If these were placed on concrete, care being taken that holding-down bolts were separated by not less than one inch of concrete from any structural steel work, the insulation would be sufficiently good. The bus zone protection at Table Bay Power Station is not yet in commission, thus it was not possible for me to give any indication as to how it would function, but we know it works at other places.

Street Lighting: The replacements in Capetown are done during the slack period, from 9 p.m. to midnight, and the early hours of the morning by the same men and the same transport as attend to consumers' reports. The men would be on duty

in any case and the cost of this work is, therefore, reduced. Some years ago the period between lamp replacements was found to indicate an average life of approximately 4,000 hours. On going into causes of this extraordinarily high figure it was found that in many areas the voltage supplied to street lamps was well below 220. The low voltage was corrected by providing more feeding points for the street lighting system, and the systematic inspection for finding lamps not burning reduces the length of time that a lamp can be out of commission.

On the question of an inter-connected overhead reticulation ,although this might perhaps give slightly more efficient use of the copper, both in cables and the overhead construction, my experience indicated that it did not conduce to a greater reliability of supply. The numerous branches and whole trees that fall on our lines during storms militate against this method in Capetown. I think it would be a retrograde step to adopt this method, continuity of supply being our first consideration.

Originally Capetown had attempted to work to a distance of approximately one (1) mile between sub-stations but, as the load increased, it was found to be better from every point of view to reduce the distance between sub-stations rather than to increase the size and run out more feeders. I am of opinion that this policy should be adopted until the total length of distribution, underground feeders and overhead network, does not exceed 300 yards from th sub-station, and when the load is particularly heavy to something less than this.

High rupturing capacity fuses have not been in use in Capetown for a sufficiently lengthy period to permit the expression of and definite views as to their merits in comparison to our existing practice. I think, however, that the whole protection of the low tension distribution system, from the sub-station low tension busbars to the consumer's residence, might be dealt with in this way. Oil circuit breakers are used in sub-stations on the low tension feeders very largely to provide a totally iron-clad job, so that it is impossible for anyone visiting the sub-station to hurt himself by getting a shock from live conductors. The oil circuit breaker has not the same characteristics with regard to current and time as the high rupturing capacity fuses, and sometimes operated on a fault which might have been cleared without making the whole section dead. For small transformers used on rural low tension lines, experiments have been carried out with high rupturing capacity fuses by adopting the largest fuse which would blow if a short were placed between one phase and neutral on the far end of the low tension lines.

As regards the use of Buchholz relays as a safeguard against continuous overloads on transformers, I would point out that before the transformer could be seriously damaged through overheating, some gas would be given off from the oil which, the makers claim, would be sufficient to operate the relay.

The use of four-wire services to individual domestic consumers has been adopted in Capetown to prevent, as far as possible, any consumer being entirely without supply. I would like to see the consumers in adjacent areas supplied through two and four-wire services respectively and careful records taken to see whether, in effect, there was any real advantage from this point of view in favour of the four-wire service. If not, the use of two-wire connections would be justified on account of their lower cost and simplicity.

I think the views put forward by Mr. Clinton (Salisbury), that every consumer in the area of the Municipality has a right to supply is somewhat revolutionary but, nevertheless, I am of opinion that as time went on this view would be more generally accepted than at present.

Communicated:

In further reply to Mr. Pirie: The reason for putting the street lighting mains above the distribution mains is that they do not interfere with the service connections to individual houses, the space for which is somewhat limited as it is not at all unusual for four cross-arms to be required on individual poles for this purpose.

In regard to his query as to what would be done in case it were found necessary to arrange for a transformer and switchgear to be installed to supply a block of flats, and particularly as to whether rent for the accommodation would be paid I would say that the point is unlikely to arise in exactly the form stated by him but sub-stations in Capetown consist of three kinds:—

1. Sub-stations for general supply: These are erected on ground owned by the Council.

2. Public sub-stations erected on private property. In this case the accommodation is leased for a specific period (not less than 20 years), the conditions of the lease may or may not provide for a rental.

3. Private sub-stations on consumers' premises. In this case the accommodation is provided by the consumer who also pays the cost of the sub-station equipment.

The Convention adjourned at 12.55 p.m.

WEDNESDAY, 7th December, 1938.

The Convention resumed at 9.30 a.m. in the Ball Room of the Arthur's Seat Hotel, Sea Point, the President in the Chair.

REPRESENTATIVES ON SAFETY FIRST COMMITTEE.

The President: There was one matter in connection with the election of officers that was overlooked, namely the election of representatives on the Safety First Committee. I understand that last year Messrs. Wright and Rodwell were elected, and I would like to know whether you are agreeable that these two gentlemen shall be again appointed?

Agreed.

SUPPLY REGULATIONS.

The President: There is another rather important matter held over from last year; that is the promulgation of the Electricity Supply Regulations. At the last Convention a draft set of Regulations was handed to the members of our Council which was then hoped would soon be promulgated but unfortunately delays have taken place which I am sure were quite unavoidable, and in discussing the matter this morning with a representative of the Electricity Supply Commission, I find that the Commission has been exploring ways and means of getting these Regulations put into force. Unfortunately up to the present it has not decided definitely upon a course of action, but Dr. van der Bijl, the Chairman of the Commission, is giving the matter his personal attention, and I am assured that a decision will not be much longer delayed. Your Council is informed that very heavy expense is involved in getting these regulations promulgated, a figure of £700 per municipality having been mentioned in this connection. You will, therefore, appreciate the need for careful consideration being given to ways and means of having the Regulations put into force throughout the country. I can assure you of the sympathetic consideration of the Inspector of Factories, who told me this morning that he also would be only too pleased to do anything he could to assist. Union legislation on the matter will, however, involve some further delays, but there is some satisfaction in knowing that there is a strong feeling on all sides that the position should be cleared up as soon as possible.

I will now ask Mr. Hooper to read his paper, "Notes on the Operation of Small Pulverised Fuel Plant."

A Small Pulverised Fuel Fired Boiler.

BY J. HOOPER,
Municipal Enigneer — ROBERTSON.

The advantages of pulverised fuel for furnace work have been known for over 100 years, the realisation that the process of burning coal could be accelerated enormously if the coal could be ground to a sufficiently fine powder so that its individual particles would readily be oxidised in the hot state.

The process was used with a degree of success in England by an Ironmaster in the midlands more than 80 years ago; at that time however, fuel economy was of little account, and little was heard of the process until the advent of the rotary cement kiln, The steady long flame—with its resulting continues and unvarying heat development inside the kiln—being ideal for this work; where the ash, which is a source of trouble in other applications, forms part of the process and is incorporated in the finished product of this industry.

Applications of pulverised fuel burning to steam raising plant were few until about 1920, when the introduction of pulverised fuel to a large steam genegator at the Lake Side Station of the Milwaukee Electric Railway Coy. shewed notable results.

Pulverised fuel firing of steam boilers then entered on a period of rapid development, and in the following seven or eight years very nearly displaced stoker firing in new plant in America, particularly in the Eastern States.

The development referred to, may be due, to a great extent, to the introduction of water cooled walls and linings to the furnace; ash removal equipment; and perhaps, more to the development of the "Turbulent Burner" in place of the earlier long flame type of burner—which was peculiarly suited to the cement burning kilns.

The Turbulent Burner, giving an improved degree of intimate mixing of coal and air in the burner, has permitted lower initial air pressures and consequent decrease in velocity of the gasses passing into the boiler, and permits a very considerable reduction in combination chamber volume for an equal heat release, previously only attained with the large furnaces associated with the long flame burner.

The original central mill system, of concetrating at one point, a group of pulverisers delivering powdered fuel by conveyer or feed-screw ducts to individual binns, serving each boiler with its complementary plant incorporating elevators, binns, driers, variable speed feeders, and air mixing equipment; involves an elaborate plant, calling for careful design and layout, occupying considerable space and involving capital costs which could only be justified in the case of plant laid out for large scale generation.

The necessity for economy in space, flexibility, and reduced first costs, led to the development of what is now known as the "rirect firing" method, consisting of a single pulverising unit, compacted—so that it could be put alongside the boiler and spplying powdered coal in a state, and fineness, suitable for delivery direct into the combustiin chamber.

The economy of space has been maintained by the development of the high speed impact mill, of which there are many examples marketed at this date, all using the same general principles; namely, that of breaking up the coal by impact, with paddles, hammers, pegs and, in the attrition types, by a combination of the hammer and peg arrangement, together with coal on coal, for the final firing.

The self contained units have now been developed in sizes ranging from those embodying mills of small capacities of 200 lbs. of coal per hour, to relately large outputs of 14,000 lbs. per hour; and have been arranged to operate with coal having a free moisture content of up to 15%, by drawing heated air, or hot gasses from the combustion chamber, through the mill.

The development of these compact types of pulverisers in the form of direct firing units, makes it possible to utilise the advantages of pulverised coal firing, in plant having a small output.
These advantages may be summed up as follows :—

1. Ability to get efficient combustion from a wide variety of coal in the same equipment.

2. Maintenance is confined almost entirely to coal equipment outside the furnace.

3. Flexibility and ease of control.

Offsetting against these favourable features the following points have to be considered:—

1. The cost of pulverising.

2. The problem of ash disposal.

3. Additional fire risk from explosion of coal dust in the system.

In arriving at a decision, and recommending the purchase of a pulverised fuel fired boiler the following points were involved :—An alteration in the process steam application by the purchasers of heating steam from the Robertson Undertaking, whereby, what had hitherto been an exceptionally flat and level demand with practically no variation throughout the 24 hours for six days a week would, by the altered conditions, be transformed to one, the graphed form of which, would resemble the profile of a ripsaw viewed from the handle, with the possibility of one or two of the peaks being superimposed at some time or other during the course of the 15 hour cycle of the process :—The existing boiler conditions being such that a variation about the working pressure was undesirable and costly.

Further the rather unsatisfactory position, from the users' point of view of the small coal supply.

The demand for run-of-mine, and round coal on the Collieries has shrunk, and is likely to shrink to still lesser volume, while the demand for the small grades of coal continues to increase, and in the future, will only be met by the Collieries crushing the larger coals or altering their system of mining to give a greater percentage of broken coal.

In either case the user of the smaller grades of coal, such as peas and nuts, may reasonably expect to have to pay more for these grades to reimburse the Collieries for their increased costs.

The process of crushing and breaking down, or mining, to meet the demands for graded smalls will yield an increasing supply of fines that are unsuited for burning on the usual form of stoker grate, but can efficiently be burnt in a pulverised form and should be obtainable for a considerable time at a lower cost than the grades for which there is a greater demand.

It appeared, that the flexibility of the pulverised fuel firing system would meet the conditions of the anticipated steam demand, and would at the same time, allow a certain freedom in the choice of fuel purchased.

With the conclusion that this method of firing would meet the conditions, the type of unit to be selected then resolved itself to that which most nearly met the following requirements:—

Size and arrangement to suit available space in the boiler house.

Cost of pulverising.

First cost.

Attention and operation.

The attribution type of mill appeared closely to satisfy the conditions in regard to space, and had the advantage of embodying as an integral part of the design, fuel feeding devices of which the following points were considered noteworthy and valuable.

The fuel at the point of entry to the mill is visible, and any stoppage or interruption can be quickly detectd. Subsequent operating experience has indicated that this feature is valuable, for, as would be anticipated the unit type of pulveriser installation has no reserve of fuel to draw upon between the mill and the burner, and the stoppage of the feed is communicated to the burner in less than a minute.

In practice it may be noted that the boiler attendants become ear sensitive to the note of the induction motor driving the mill, and that a variation of load, as reflected by the driving motor, is an effective warning of interruption or variation of the mill output.

Feed regulation, whereby the fuel fed into a small hopper, falls by gravity on to a horizontal rotating disc, over which it is spread to a predetermined depth by a vertically adjustable sleeve and the quantity of coal fed into the mill is controlled and regulated by a knife which scrapes the coal off the disc, the position of the knife, and consequently the amount fed into the mill, is controlled by a handwheel with pointer and indicating scale.

This arrangement has the undoubted advantage of simplicity, precludes the possibility of jamming and at the same time provides instant and fine regulation of the fuel fed into the mill irrespective to the size or grading.

Fuel drying arrangements enable fuel carrying a considerable moisture content, to be burned : the drying being effected by tapping a controlled quantity of hot gasses from the combustion chamber and passing it through the mill with the fuel; as the drying effect is considerable, and more stable combustion is maintained under variable load conditions.

Separation of metals and foreign matter is effected by the fuel, scraped off the feed disc referred to earlier, falling by gravity and meeting a current of air of a direction and velocity that lifts the coal out of its gravitational path and carries it into the mill: A variable orifice regulates the velocity of the carrier air current to that which will carry the coal into the mill, but will not sustain and convey material heavier than coal:- Metals, stones, and other unwanted material fall out of the air stream discharging themselves through a duct and out of the mill.

The mill or pulverising machine proper reduces the fuel to the requisite fineness in two stages, the first, in which the coal is disintegrated by being beaten by free pivoted hammers against a surrounding screen ring : After this first treatment the finely divided coal is carried over by the air current to the attrition stage where the coal particles are broken down to final fineness by self-abrasement caused by the intense turbulence of the air in the mill, generated by a series of moving impellors and fixed interrupters.

Efficiency of combustion is determined to a very great extent by the fineness of the particles of coal. Some coals are more friable than others.

The attrition type of pulveriser provides, in a simple manner, for variation of fineness by a rejector device, which, acting on the principle that since all particles of coal are carried by the slip of the air passing them, and that the larger particles will travel more slowly on the air stream than the smaller ones; a series of suitably shaped arms rotating with the shaft and rotor will intercept and reject the larger particles back into the attrition area, while the smaller particles pass to the fan, and out to the burner. The degree of fineness of the fuel being varied by the addition or subtraction of the number of these arms attached to the rotor.

It is notable that the points mentioned above, are achieved by only two mechanical moving parts, both of them simple rotary movements, (1) the feeder disc in a horizontal plane through a worm and wheel driven by a light roller chain off the rotor shaft. (2) the rotor, with pivoted hammers on one face and impellers on the opposite face of the disc, and the fan hub and blading, both carried on a short stiff driven shaft between two roller type bearings.

Cost of pulverising, this may be taken to be the total cost, viz. driving energy, replacement of wearing parts, and attendance.

The driving energy and the replacement of wearing parts is dependent to a considerable degree upon the class of coal pulverised, and the degree of pulversation. Some coals are hard and do not readily break up, and the cost of using these coals may, by reason of the energy and renewals expense, be greater than in the case of a coal having a slightly lower thermal value.

Coal has no uniform structure, and its particles when pulverised finely, vary enormously in size and shape : The degree of pulverisation required depends upon the application.

Generally speaking, the low volatile coals require a finer grading than high volatile coals : There is obviously no justification for the pulverising of the coal beyond the point at which the desired combustion efficiency is obtained. To carry the process to the production of an ultra fine product, involves additional expenditure on energy and a larger unit than would otherwise be needed.

It may appear to be a satisfactory performance to pulverise to a grade such that 80% of the product will pass through a 200 mesh screen, but if the 20% remainder is so coarse that it is lost to combustion, it would be more advantageous to be able to mill so that only 75% passed through the 200 mesh screen, providing that 85% pass through a 170 mesh screen and was used to combustion.

In the Attrition type of mill there is a very close grading of the coal particles, with a negligible variation throughout the range of the output of the mill: and having once arrived at the most economical degree of fineness required to suit the burner, and combustion chamber conditions, no further attention is necessary to provide the fuel suitable for the wide range of the mill output.

The power cost of pulverising is closely proportionate to the quantity milled, after deduction of the no-load input of power required to overcome friction and fan windage, but varies considerably with the class of coal pulverised, and to a smaller extent with the fineness of the product.

The power input, in the case of the unit type of mill is the total power; as it provides for and includes, the operation of the feeder separator, pulveriser, and primary air fan.

The pulverising of the fuel by mechanically breaking down the coal, and the creation of the turbulent conditions for attrition of the coal particles to the required fineness, of a necessity involves rapid wear to the metal parts creating these conditions, and the successful operation of the unit type of pulverising mill depends to a very great extent, upon the design of the unit being such as to protect the whole of the metal surfaces exposed to abrasion by sectional wearing pieces, arranged for ready replacement that can be effected cheaply and with a minimum of lost time.

The depreciation of the wearing parts is progressive and can be expressed as a function of the quantity of coal passed through the mill.

The class of coal used would have a small bearing on the life of the wearing parts; and for any of the coals in general use in South Africa, reputable manufacturers are prepared to guarantee a renewals cost figure based upon the number of tons milled.

The attendance necessary is very small, and the boiler attendant has no mannual pre-occupations, and can direct the whole of his attention to securing the most effective combustion conditions to meet the load demand of the moment.

The flexibility with which load variation can be dealt with, eliminates the necessity for any intelligent anticipation of conditions to be met, or preparation to deal with the result of those conditions.

Load peaks and valleys can be dealt with as and when they arise; a feature that results in considerable fuel economies, where the loading is subject to wide and sudden fluctuations as may be met in plant operating on a traction load or meeting demands for process steam in distilling or other evaporative work.

Quick response to load variation is illustrated by the following extract from an American Journal of two years back, which instanced the case of a pulverised fuel fired boiler in an American Power Station which was acting as a peak load station to an Hydro Electric Plant.

Due to faulty transmission lines the ties between this station and the Hydro Plant were disconnected, load increasing from 10,000 to 29,000 K.W. The boiler in use at the time was steaming at the rate of 130,000 lbs. per hour—which was increased to 300,000 lbs. in one minute—in three minutes to 400,000 lbs., and in eight minutes to 440,000 lbs., by which time one of the tarnsmission lines was cleared, and the load re-transferred to the Hydro Plant. The steam pressure during this period of 11 minutes dropped only 440 lbs. to 380 lbs. after which the station was back to its former load.

In the first cost, of a unit type of mill suitable for the size of steam generator under consideration, there is little to choose between the pulverising mill and the standard chain grate stoker, with perhaps a slight advantage in favour of the pulveriser unit.

The steam raising equipment calls for little detailed description, and consists of a "John Thompson" Beta Type Water Tube Boiler having four drums, with bent tube heating elements set nearly vertically, with short circulating tubes connecting the two upper drums, with a similar tube arrangement coupling the lower water drums. The boiler is suspended from steel girders resting on and supported by steel columns, and is fitted with an integral superheater suspended between the front and near heating elements. The Boiler was designed for hand firing and fitted with a rocking bar type of grate for ash clearing.

The leading dimensions being as follows:—

Heating Surface	1790
Tubes wide	14
Vertical centres	12 ft.
Grate Area	50 ft. approx.

Steam conditions are as follows:—

Working pressure	175 lbs. per sq. ins.
Superheat	550/600° F.

The modification of the boiler to suit the pulverised fuel burning equipment was undertaken by Messrs. The Dryden Engineering Co. of Johannesburg.

The design of the vertical tube type of boiler lent itself to the proposed modification, and the standard arrangement of setting was varied only, in providing additional combustion chamber volume up to the limits of the available space in the boiler house building, and by the provision of a duct to tap hot gasses from the combustion chamber.

To provide the combustion chamber volume, the whole of the boiler setting was raised to the limiting clearances of the roof ties of the building, while the boiler front was projected forward under an arch 12 ft. high to a depth of approx. 4 ft. with provision for explosion doors and an outlet from the combustion chamber for the hot gas duct; and the provision of a cirular opening in the boiler front wall to introduce the burner head.

The boiler was originally provided with openings in the side walls for the insertion of a hand lance for dusting the tubes.

To effectively clean the tube surfaces under the pulverised fuel firing conditions an externally operated dust blowing equipment was installed, one set of rotating jets for each of the front, back, and superheater elements with a fourth unit with a retractable rotating head mounted in the combustion chamber for dusting the facing tubes of the front element.

With the modified setting the combustion chamber area was increased by approx. 20% to 1,000 cu. ft. and giving a ratio to heating surface of 0.58, which may be thought small, but it is probable that the effective heating surface is not so disposed as to support the rather spectacular rates of heat exchange that have been attained with the most suitable arrangement of conducting surfaces.

The plant was put into commission in September last.

The operating staff was without previous experience in pulverised fuel equipment, and satisfactory operating results had to be obtained by trial and observation.

While it may be strictly stated that any description of coal may be burned in the pulverised state, the milling and burning characteristics vary to a very striking degree.

The most suitable coals both in size and thermal values had to be tried out by sample deliveries.

These excursions into combustion were in a sense adventurous and the conclusions of one day were not confirmed the following day and were at times completely shattered a few days later.

In submitting these notes to members it is realised that without supporting statistical data reflecting the actual performance of unit as a steam generator the most essentially interesting part of the subject matter is missing and the indulgence of members is asked for the omission of such data; while care has been taken to avoid a misleading conclusion, the figures given have not been registered over a period long enough to present an accurate and trustworthy reflection of the capacity and efficiency of the plant.

The coal used has varied from a good grade of Natal coal to the poorer description of Transvaal productions; of which, analysis shewed the following variation. B.T.U's 13960/10235, Moisture .51/3.8. Fixed and Volatile Carbons 77.1/88.96. Ash 7.3/22.3.

The conclusion from tests of the varying description of coal would indicate:— that whether used on a grate or in a powdered form, it is not profitable to pay haulage at the rate £1 a ton on ash:—that in the pulverised form coals having a low ash fusion point which by themselves have a tendency to troublesome birdnesting can be satisfactorily used by admixture with a relatively small quantity of coal whose ash has a different chemical constitution and fusing point; that in some cases coal having a slightly higher calorific value cannot be pulverised as cheaply or effectively as others with a lower value and the advantage may be with the lower grade of coal; that the cost of milling per ton may vary with the description of coal used from 16 to 32 KW, and that no marked difference was noted in burning of coal having fixed and volatile carbons content varying by as much as 15%.

Operating presented little difficulty.

At low loads there exists a loss due to unburnt gasses in the flue, which condition improves with increase in load, attempts to effect more complete combustion by shortening the flame and getting increased radiation from the front wall were unsuccessful and resulted in the slagging up of the brickwork about the burner.

The best performances recorded appear at the higher loading and rates of firing, and are probably a reflection of the higher furnace temperatures, as the temperature of the gasses at the damper were not appreciably increasd at this loading:— with an evaporation at ehe rate of 6500 lbs. per hour the fuel fired gave a figure to 7.8 lbs. of water per lb. of fuel or approx. 10 lbs. corrected to 212°, while at a boiler loading of aprrox. half the above rate the evaporation figure is 7% worse and is consistant with the average results of a month's operation.

Ash removal presents a problem, as the ash is light and is practically air borne; of the total ash, about 30% falls in the boiler on the floor of the combustion chamber and between the tube elements of the boiler, a further 10% is carried up the stack and is carried into the atmosphere with final dispersion over a very wide area.

The greater proportion of the ash lays in the flue duct, and is costly to remove, whether done by hand or mechanically.

The boiler house conditions are not good, and under the present arrangement the natural draught conditions permit a considerable amount of dust to be blown out into the boiler room when the tubes are being dusted. It is anticipated that these conditions will improve with the completion of the installation of mechanically induced draught equipment.

Shutting down the plant is effected by doing no more than cutting off the coal feed to the pulveriser, with the single precaution, that sufficient time is allowed to clear the mill of coal in circulation, before stopping the driving mechanism.

In the case of an emergency stoppage, traps are provided in the mill to enable it to be cleared by hand before restarting.

Starting up the plant after stoppage of any duration can be readily done in this particular installation, as the original two hand firing doors were left as access doors to the combustion chamber. Starting up from the cold state can be done expeditiously by building a heaped fire of round coal in the opening behind the doors, to warm up the boiler, and later, on starting up the pulveriser supporting the combustion of the pulverised fuel by a torch or oil burner jet for about an hour.

Restarting after a temporary stoppage presents no difficulty, as it has been found that the combustion chamber walls remain sufficiently hot for any period up to two hours to ignite the coal and resume stable firing conditions.

The maintenance, as referred to earlier, of the unit type of pulverising mill is confined to cold equipment, and the successful operation of the plant depends to a great extent upon the design of the machine.

Working as it does in a comparatively cold state, access for renewals can be made instantly, while the simplicity and light weight of the rotating and wearing parts facilitate the fitting of renewal parts, the time needed to fit the parts can be accurately forecasted, and the extent of the replacement work can be arranged to suit the time available; for example, the spare rotor previously fitted with new hammers and wearing plates, and balanced ready for use, can be assembled and the mill restarted with a total stoppage of not more than an hour .

In regard to the renewals cost of the wearing parts, the plant has not been in operation for sufficient time to express an opinion. It is noted in this connection that American operators of pulverised fuel plant, conclude that the life of the grinding elements is inversely proportional to the quantity of ash and pyritic sulphur in the coal, and bears little relation to ease of grinding; and are favouring the building up, by welding, of worn parts with specially suited abrasion resisting alloy steel.

I would thank you Mr. President and Members for the opportunity of presenting these notes, and should the subject prove to be of interest to other members who may desire fuller information of the financial and economic results of the installation of this type of coal burning equipment, I shall be happy to afford all such information as may become available when sufficient time has elapsed to confirm my anticipation that this method of firing can produce valuable results in small as well as large steam generating plant.

The President: Thank you, Mr. Hooper, for your paper, and with your permission we will have the discussion to-morrow.

Agreed.

The Convention then adjourned for refreshments.

On resuming, Mr. Stubbs showed a number of slides illustrating the features of sub-stations in the Council's Electricity Undertaking amplifying his paper read on the previous day.

The President: We owe Mr. Stubbs a debt of gratitude for the trouble he has taken in showing us these pictures. (Applause.)

FILM ON CIRCUIT BREAKER TESTS.

I now have pleasure in calling on Mr. England to show us a film dealing with the Short Circuit Testing of Switchgear, which, I am informed, was shown at the last Convention of the Incorporated Municipal Electrical Association of Great Britain.

FILM ON TABLE BAY POWER STATION.

The President, after expressing thanks to Mr. England, showed a film, on which he gave a running commentary, illustrating the construction of the Table Bay Power Station.

The Convention adjourned at 1 p.m.

THURSDAY, 8th December, 1938.

The Convention resumed at 9.30 a.m. in the Ball Room of the Arthur's Seat Hotel, Sea Point, the President in the Chair.

DATE OF NEXT CONVENTION.

The President: Your Council has again gone into the question of the date of the next Convent and has given very careful consideration to the various points of difficulty that arise in this matter. As the outcome of its further deliberations your Council have decided to recommend that, having regard to all the circumstances, the best possible dates are November 20 to November 23, 1939, inclusive, since that period appears to conflict to the minimum extent with the municipal elections in the various Provinces and with the probable dates of other Conferences on which Municipalities will be represented.

The dates recommended were agreed.

DISCUSSION ON MR. HOOPER'S PAPER.

The President: I now invite discussion on Mr. Hooper's paper whch was read yesterday.

Mr. F. D. Opperman (Capetown): We offer our congratulations to Mr. Hooper upon the excellence of his paper. We have such little information available on the operating of South African Pulverised Fuel Plant that there is quite a lot still to be done. Mr. Hooper referred to only one particular type of coal pulveriser, but it may be pointed out that there are other types that might be equally satisfactory. I am sure we shall look forward next year to having further details from Mr. Hooper concerning his tests.

Mr. Swingler: The notes on Mr. Hooper's experience to date on a pulverised fuel installation at a comparatively small steam power station are of special interest to a large number of our members in view of the increasing difficulty that is being met with in obtaining the required quantities of high grade pea coal for combustion in mechanical stokers at the coastal towns and he is to be congratulated on his courage in taking this step to avoid the consequences of serious shortage of pea coal supplies such as he has experienced in the past and anticipates meeting in the future. Although the larger Undertakings are to some extent in a stronger position than others in this respect we, in Capetown, using approximately 600 tons of coal per day, have also met with such difficulty during certain months of recent years as to cause us to instal coal crushing plant at the Table Bay Power Station capable of producing the whole of our present day requirements of small coal from round or run-of-mine coal. This has been done merely as an insurance against a repetition of the menace to the maintenance of full supplies of electricity that has been experienced in the past through diminution in coal deliveries to a point far below the requirements of the local power stations.

The fact that a pulverised fuel installation provides a wider field from which coal supplies may be drawn under such emergencies without serious loss in efficiency when using lower grade coal is also an important consideration to a power station which might at any time be faced with the position of having to accept virtually any grade of coal from any available source and is a matter to which I personally would give very careful thought in connection with the design of any new large power station in this district.

Mr. N. Reynolds (Johannesburg): Mr. Hooper is to be congratulated on his contribution to a subject which has received comparatively little attention in this country. The problem of burning South African coals in pulverised form offers a wide field for intelligent experiment and observation.

Mr. Hooper, in his Paper, refers to one type of Coal Mill only, but it may be pointed out that there are several other types which would give equally satisfactory service under the conditions specified. There are, of course, many cases where the high-speed mill can be used with convenience and advantage, and the majority of manufacturers of pulverising plant have both high-speed and low-speed designs available, so that it is not the purpose of these remarks to criticise either type but rather to bring forward some of the main features of each and to compare the system with the more usual mechanical stoker.

It can be said that, other things being equal, the maintenance cost of a slow-speed machine should be lower than the similar charge for a high-speed unit and this principle holds good, particularly in the case of pulverising machinery.

In putting the case for the slow-speed type of pulverising mill, there is one important point which is often overlooked, this being in connection with the drying of the coal before firing. Owing to the much longer period during which the coal charge remains in the slow speed mill, it is possible to make use of a lower mean temperature within the body of the mill than is the case with the high-speed type of machine in which the coal passes from feeder to furnace in something less than one minute. This feature, I suggest, should make for lower maintenance costs.

A further point of interest is in regard to the flexibility of the two main classes of pulveriser, and in this respect it is true to say that the fineness of the product from whatever type of mill varies in inverse ratio to the quantity of coal drawn from the unit, and bearing this in mind it would appear that the larger charge of coal in the slow-speed mill being in a fine ground and partially ground condition, should offer the ability to make sudden demand for fuel with greater ease than can be met by a high-speed type of mill containing a very small quantity of coal which remains in the mill for a short period only. Both types of mill under overload conditions will deliver a coarser product, but the large slow-running mill has a reserve of coarser particles awaiting fine grinding, whereas the small high-speed machine must pass the required quantity of coal straight through without loss of time.

Dealing in more detail with Mr. Hooper's paper, it would seem that the question of coal is one that requires special attention, and it may even be necessary to make use of carefully compounded mixtures of coal in order to avoid slagging and bird-nesting troubles. Such a position occurs with stoker firing only when the poorest grades of coal, having a calorific value below 9,000 B.Th.U.'s per lb., are used, and it is even possible to burn such low grade fuel without admixture on modern mechanical stokers with correctly designed arches and furnace setting. In this connection it may be of interest to members to know that at one installation in the Union, coal, of which approximately 50 per cent. passes through a $\frac{1}{16}$" mesh sieve, is being successfully burnt on a modern design of mechanical chain grate stoker.

On the score of flexibility, it has been claimed that there is an advantage in favour of pulverised fuel plant, but I suggest that a modern mechanical stoker, with a properly designed furnace, will meet all the average, every day fluctuations of load which are met in Municipal service.

May I say that, having in mind the short time the plant has been in commission, Mr. Hooper has been able to give us a great deal of information, and I add my hope that at the next Conference we may hear further from Mr. Hooper after he has had the opportunity to study the behaviour of his plant for twelve months.

The President: Mr. Hooper has kindly consented to communicate his reply.

REPLY (Communicated by Mr. J. Hooper)

Replying to Mr. Swingler: The increasing dependence of the community in general upon the uninterrupted continuity of electricity supplies for health, wealth and comfort is not confined to the larger towns. The smaller country towns with little pretensions are users of electricity in these times, to an extent that perhaps may not be realised by superficial acquaintance, and any interruption or threatened interruption of the continuity of supply, cannot be contemplated lightly, it would not be tolerated.

I think Mr. Swingler has put his finger on the most important point which I was endeavouring to present in the paper under discussion, that is the desirability, in planning power station equipment, to meet the changing position of coal supply, and the possibility of taking advantage of development in the science of combustion, where such developments can be applied and profitably utilised.

In the coastal areas of the Cape the delivered cost of coal is relatively high and the high-speed pulverised fuel mill equipments do offer possibilities of attaining efficient combustion at low capital cost and at the same time will enable operations to be continued with widely varying descriptions of fuel should the necessity arise.

Replying to Mr. N. Reynolds: In putting forward the case for the slow-speed type of mill Mr. Reynolds submits that the maintenance costs of the slow-speed machine should be lower than those of the high-speed type of machine, a comparison of the maintenance costs of the pulverising units alone would probably support the assumption. I would suggest, however, that a more equitable comparison would be to include in the slow-speed mill costs, the maintenance of the ancilliary equipment where the advantage would probably favour the high-speed unit.

In regard to the drying of the coal the Unit type should show an advantage as the quantity of air to the mill is greater and may be as much as 60-70 per cent of the total air. It is passing through the mill at a high velocity, in a state of turbulence, and in very intimate contact with the coal in its most finely divided state, all being conditions which should be favourable for the exchange of heat and rapidly drive off excess moisture from the coal.

In regard to the point of flexibility, if the mill is designed to effectively pulverise up to a specified quantity per hour or per minute, any increase in size to serve the purpose of a storage bin for overload conditions would adversely affect the operating cost by increased first cost.

In regard to the selection of coal there is a very marked variation in the constitution of coals found in the Union. Ash with a low fusing point is not confined to the lower grades of coal, in fact one of the best qualities of the Natal coals is extremely difficult to use at high rates of steaming on a stoker grate on this account, a difficulty which has been found to be more easily overcome by mixing through the pulveriser than I had been able to attain by the same means on the stoker grates.

Whether stoker fired or fired in a pulverised form, careful selection of coal to suit furnace conditions can effect a substantial reduction in maintenance charges.

It is indisputable that very considerable improvements have been made in the modern mechanical stoker and that many of the outstanding steam generating performanes have and are being consistently attained with stoker fired plant, but my limited experience does encourage the hope that a pulverised fuel fired plant can offer efficient operation, a flexibility, control in its simplest form, a wide choice in grade and size of coal used at a first cost that makes it accessible and valuable to the small station.

SUPPLY REGULATION—SUB-COMMITTEE.

The President: Regarding the promulgation of the Electricity Supply Regulations, your Council realise that any steps that Dr. van der Bijl may take require action on the part of the Municipalities to give effect to them, and it has been suggested to the Council that each Province should appoint a representative to serve on a sub-committtee whose duty will be to see that the way is made smooth for carrying out the Regulations. If you are in agreemnt with that I shall be pleased to receive nominations for the sub-committee.

The following were nominated and declared elected: Messrs. Harvey (Springs), Gyles (Durban), Eastman (Capetown) and Pirie (Bloemfontein), with the following as alternates: Messrs. Ewer (Pietermaritzburg), Hugo (Pretoria), Rossler (Cradock) and Behrens (Port Elizabeth).

RELIEF OF RATES.

The President: There is one other important matter to be dealt with, namely, the question of the Relief of Rates. You will remember that a sub-committee was appointed last year to go into the question with a view to reporting to this Convention. This sub-committee held a meeting a few days ago and discussed the matter with a view, if posible, to submitting a unanimous recommendation. I regret to report that it was found impossible to obtain unanimity, and the sub-committee is, therefore, unable at this stage to submit a report to the Convention.

Mr. Swingler: I am sorry you have adopted the easier method of putting this question into cold storage. I also feel that you will never get unanimity on this subject. If you do not deal with the principle you will never get anywhere. It is purely a matter of principle, and I do not see that we should worry about anything else. We have no right to come here unless we say what we mean. I have been in the service of my Council for 21 years, and I have not hesitated to say exactly what I thought, and my Council do not think any the less of me for that. You will never get anywhere with this if you only consider how it is going to affect your revenue and in how far it can be used as a taxing machine. I hold the honest conviction that it is wrong in principle, and it is the principle that matters. (Applause.)

Mr. Clinton: Does Mr. Swingler suggest that the sub-committee shall continue in office?

Mr. Swingler: It can do no harm. (Laughter.)

Councillor James: I think when Mr. Swingler says he thinks it will do no harm he is speaking with his tongue in his cheek. He is not going to lie down because he was unable to do anything this year, and I feel sure that he will go on hammering away at the principles involved. Last year Mr. Spilkin put forward the view that part of any surplus should be returned to the consumers, and Councillor Hofmeyr stated that he did not agree in principle that large amounts should be taken from an Electricity Undertaking for the relief of rates, but in his own Municipality of Stellenbasch he felt it was only right that large consumers should get back a little. I think we should go on and explore the avenue suggested by Councillor Spilkin. It cannot do any harm, and it may be that we shall be able to do a little good. (Applause.)

Councillor Robbins (Maritzburg): I hope we shall not have the whole debate over again. We have pursued this subject ad nauseum. I do hope we shall not waste the time of the Convention by going all over it again. At last year's Convention

I said we had a rough road to hoe. How long and hard it was I did not then realise, but when I got back I was promptly told I should not have voted as I did, but they could never convince me, as an accountant, that the views put forward by Councillor James were not right. (Applause.)

Councillor Capell (Durban): This matter is not founded upon the facts that some would have us believe. We have the fact that municipal trading undertakings are there to assist the ratepayers. In Natal we have the classical example in Durban to show that it is ridiculous to try and prohibit a contribution going to the users of the Undertaking. The Provincial Council prohibited the Durban Municipality from taking a 4 per cent. contribution towards the relief of rates from the Abattoir because they felt that the users would not benefit. It has been found that this view is founded upon a fallacy. You will find that the same thing was done in connection with the Electrical Undertaking. I feel that we have reached a stage in our Electrical Undertaking where it is no longer an inducement for the consumer to increase his supply or to provide any additional bentfit when we have reduced the tariff. Tariffs can be reduced to a figure at which they do not represent any real benefit, and I am speaking as the representative of an Undertaking which supplies Electricity at the lowest price in the Southern Hemisphere to the domestic consumer. We take from the Undertaking a large sum for the relief of rates, and we also make the Undertaking pay for street lighting, and despite that, we can supply current at a rate which which it will not be any real advantage to the consumer to reduce any lower. We have just made reductions to the extent of £26,000, but I feel that the actual amounts in cash the various consumers will receive as a result of this reduction are not of any great material benefit. It is far better, and of far greater advantage to the town as a whole for that money to be spent upon the useful development of the City and the provision of amenities. I feel that if this agitation were to succeed the same thing would happen as has happened in Natal in regard to our Abattoir.

Councillor Spilkin: This matter was very thoroughly thrashed out by the Committee, and I would like this Conference to keep one point at the back of its mind—who is the man who has to shoulder the whole burden of the town? Is it the property owner or the ratepayer? Who has to carry the responsibility for any losses, the property owner or the small man? This is a point that confronts the small Municipality particularly, where you have your various trading concerns, the costs of which are invariably greater than those of a private concern. Unfortunately we have to look to our electric light to help us ou . That is the only department that makes a profit and the man who has any interest in the town cannot object to its helping towards its upkeep. Then you come to the position of the town where there are Government buildings and where the property owner has to shoulder his portion of the expenditure. It would be very difficult to apply a hard and fast rule in a matter of this kind, and it would be bad policy to try and get the Government to interfere. We feel we have quite enough Government interference already. (Applause.)

Mr. Rodwell: I hope we are going to get along with the agenda, and, therefore, I second the proposal that we get on with our work.

The President: I must declare the discussion closed unless someone has a new point to raise. The next paper is by Mr. Milton, and I have pleasure in now calling upon him.

Automatic Plants for Small Municipal Schemes.

by W. H. Milton,
Electricity Supply Commission.

The paper which I had the honour to present to the Association in Johannesburg in 1935, included mention of the possibility of utilising automatic generating plant for Municipal schemes when potential revenue was insufficient to support a permanent staff. This was done in the hopes that your members might express their views on the introduction of such plant, particularly from the aspects of employment and the prospects of the ultimate success of an undertaking inaugurated on this basis.

During the course of discussion on my paper, Mr. Muller made the very pertinent statement that very few of the small schemes (in this country) were self-supporting from their inception, but he attributed this mainly to the high cost of distribution required to reach scattered consumers making up a typical small lighting scheme. He also pointed out that with present day progress, there is very little to recommend the use of direct current in favour of alternating current, even though a restricted hour service is decided to be essential at the time of inauguration of the scheme.

While condemning direct current, he claimed that a few storage batteries have given excellent service, but most have been a failure due to inevitable abuse, and that, once installed, replacement of cells has been the line of least resistance.

In defence of the Engineer-in-Charge of these smaller plants, he pointed out that he is usually his own shiftsman, linesman, etc., and "has to train a local lad or two to assist him, which must lead to neglect."

While Mr. Mail implied that automatic plant would only be of use for supply to from 50 to 80 consumers for lights only, he added that an engineer would be needed to look after the undertaking which to some extent defeated the object of such plant.

Mr. Clutterbuck pointed out that Regulation 11 (1) of the Factories (Amendment) Act of 1931 required the operation of machinery to be in charge of a competent shiftsman, though he had powers to grant exemption, and that he was prepared to take the reasonable view and consider each case on its merits, with the qualification that any exemption granted would cease to have effect in the event of any increase in the capacity of the plant, at which stage the position would require to be reconsidered. He expressed the fear, however, that the introduction of automatic plant would not react satisfactorily on employment, as his experience with small Municipalities had shown him that any instruction to provide an operating staff, after having used an automatic plant, would be likely to be met with strong opposition.

Dealing with the electricity distribution aspect, however, he pointed out that an arrangement, whereby automatic plant might be placed in charge of an inexperienced person, could not be accepted, as his evidence as regards the number of accidents occurring on small Municipal distribution systems indicated that, for the protection of the public, it is necessary that a competent person should be placed in charge of electricity supply undertakings, however small.

The "reply to discussion" dealt briefly, inter alia, with these points. I feel, however, that sufficient interest was shown in this section of the former paper to warrant the preparation of the present paper.

It may be significant that since the Convention at Johannesburg, five of the types of plant I had in mind have proved acceptable for installation, and at the moment, two of these operating as fully automatic plants, are actually in service. Insufficient time has elapsed to enable to enable any opinion to be expressed as to the effective functioning of the plant in question, but a contribution at a later date from the Consulting Engineers concerned, would possibly prove welcome to your Association.

From an economic point of view, it is first necessary to decide whether or not the installation of automatic equipment will show a saving taken over a sufficiently long period. In this connection it must be accepted that as soon as the scheme is in a position to meet the cost of employing an operating staff, the owners will be required by law to employ such a staff, thus rendering the automatic features redundant to a large degree.

In many instances, projected small schemes are considered for adoption on the basis of staff at such low rates of pay that it is unreasonable to presume that the plant would receive competent attention. When such schemes are adopted, it is usual to find after a brief interval that neither the owners of the plant, nor the staff are satisfied, and the finances are suffering. In brief, not only is the plant badly abused (neglect is abuse) to the detriment of the owners, suppliers, and manufacturers of the plant, but a false impression of the possibilities of electricity supply is created.

To equip a generating installation with automatic devices is not a very expensive matter (though the cost is certainly appreciable), but it is necessary to compare the cost of the equipment with the sum which would otherwise be spent on salaries and wages over a period if the plant were not made automatic at the outset.

Attendance cannot be dispensed with entirely, as occasional supervision is required for normal maintenance, and therefore for the purpose of comparison, the "automatic" scheme must include a portion of the salaries and wages bill of a completely attended plant. This aspect introduces the possibility of consideration being given to semi-automatic equipment with provision for attendance at the power station during the peak load period shift.

Little difficulty is likely to be experienced in arriving at a decision in these matters, because border-line cases are not likely to occur, the salaries and wages bill of a small scheme being such a large proportion of the total annual expenditure that the difference between the two types is very considerable.

Before considering the principal functions to be performed by automatic equipment, it is necessary to visualise the possibilities of both the direct current and alternating current systems of supply. If the alternating current system is adopted and appliances are used by consumers which are not of the "Universal" type, then it is necessary that rotating machinery be employed throughout the period of supply. If, on the other hand, consumers are not permitted to make use of any apparatus which is not of the Universal type, then it might be possible to arrange the feeder and reticulation circuits in such a manner that, during very light load periods, the three phase, 4 wire feeder system could be converted to a 2 wire system by change-over switchgear.

If this could be done effectively, it would be possible to provide a battery to maintain supply during light load periods, the battery being charged by means of either rotary or static converting equipment at convenient times. If such a scheme is contemplated, it would, of course, be necessary to make sure that the neutral (or "4th wire") would be of sufficient cross section when acting as the "return" for the three phase wires as one conductor.

This should not present an insuperable difficulty in view of the extreme difference between the currents carried at peak load (for which the three phase system would be designed) and the current loading during light load periods. If the ratio of difference were 3 to 1 and the neutral conductor were the same size as the outer or "line" wires, the neutral would carry not more current during light load than the outers during peak load, but the volt drop would, of course, represent a higher proportion of supply voltage at the time.

Having in mind these possibilities of supply, the following may be regarded as the principal features to be taken care of in the design of an automatic power plant :—

1. Features Common to all Systems :

(a) Automatic starting of the prime movers.

(b) Protection against—
- (i) Failure of circulating water ;
- (ii) Excessive temperature rise of circulating water ;
- (iii) Failure of lubricating oil supply ;
- (iv) Excessive temperature of lubricating oil ;
- (v) Bearing seizure ;
- (vi) Overspeed.

(c) Voltage Regulation.

(d) Automatic paralleling equipment if two sets are to be operated in parallel.

2. Particular features of direct current plants :

In addition to the requirements mentioned under 1, automatic equipment must be provided for :—

(a) Shutting down the generating plant at some predetermined minimum load ;

(b) Starting up at predetermined maximum load on the battery ;

(c) Voltage control on the busbars both during the battery discharge and battery charging processes to maintain sufficiently constant feeder voltage ;

(d) Effective charging of the end cells ;

(e) Protection of the end cells against excessive charging ;

(f) Effectively charging the battery as a whole, irrespective of the characteristics of the load of the undertaking.

3. Simple alternating current schemes :

The additional provisions mentioned above in (1) need not be expanded at this stage.

(4) Plants to supply both alternating and direct current :

In addition to the features under (1) above, the following would be required :—

(a) Equipment to ensure that the A.C. and D.C. supplies could not be interconnected ;

(b) Automatic change-over switchgear to regroup the wiring appropriately to suit alternatively each of the two types of supply ;

(c) Direct current voltage control to maintain effectively constant feeder voltage throughout discharge of the battery ;

(d) Means for the adjustment of the charging rate to match the loading on the battery ;

(e) Load operated control equipment to ensure transfer of the load from the battery to the A.C. generating sets or vice versa when appropriate loading conditions are reached (i.e. " starting " and " stopping " equipment similar to that mentioned in (2) above).

Apart from these principle aspects there are many details which must receive very full consideration, being of sufficient consequence as to mar the success of any contemplated scheme is neglected.

In a manually operated station which is well run, steady voltage and constant supply are probably two of the most important aspects from the consumers' point of view. To give satisfaction as regards steady voltage it is usual to equip a station with automatic voltage regulators operating on the generator exciter circuits. This is done in addition to providing a feeder and reticulation network designed to secure feeder voltage drops of reasonably low values. A similar service therefore must be given from an automatic station if it is to be accepted by the consumers as a satisfactory undertaking.

In order to maintain uninterrupted supply it is necessary that generating plant and equipment must be maintained in good order and condition. With oil engines as prime movers this necessitates the routine cleaning of valves and/or ports and tuning of atomisers. This work cannot be said to be necessary at any fixed interval of time because an oil engine running for a lengthy period at very low loads will require more frequent attention than one operating at reasonably high loads for the same length of time. i.e. Plant load factor has an important bearing on routine maintenance.

An automatic plant, therefore, which only requires the operation of the oil engine prime movers at times of relatively high load, and includes equipment to maintain the load on the generators at a high load although the network load may be low during the battery charging process, has a decided advantage over automatic plant which requires the operation of prime movers continuously irrespective of the magnitude of the load, unless arrangements are made to instal several oil engines of "graded" sizes to suit expected load variation.

The modern storage battery is an effective piece of apparatus which, with reasonable treatment, will have a long efficient life. This statement can be accepted whether acid or alkaline type batteries are used. With certain reservations a storage battery will give efficient service throughout a load range variation from full load to very low loads and it does not therefore suffer the same disabilities as the oil engine in this connection.

TYPE OF LOAD TO BE SUPPLIED :

The requirements of the plant depend on the form of the daily load curve, and therefore it is necessary to determine this from the nature of the potential consumers any projected scheme is to supply.

In the experience of Engineers in this country it is found to be a general rule that at the inception of a very small scheme, very little use is made of electricity except during the hours from about dusk to 9 or 10 p.m. During the remaining hours of darkness electricity is rarely used except for street lighting purposes and for pumping the town water supply if this is necessary. During the day, however, electricity is often used for the usual household accessories such as irons, kettles and hotplates and occasionally for cooking when the tariffs have been correctly designed.

In the author's view the extent to which electricity is likely to be used for purposes other than lighting is influenced to a far greater extent by the tariffs for supply than by the type of consumer supplied. Even in relatively poor communities, if hire purchase facilities are available for the acquisition of apparatus, and if electricity is available at reasonable prices, though it may be used as a luxury at the outset, such consumers are the first to realise the benefits of electricity as an essential to household economy particularly in the matter of minor luxuries.

Considerably good work could be done in many communities by a series of lectures and demonstrations framed to educate consumers in the economic use of electricity and its reflection in reduced expenditure on the materials used by the housewife due to certainty of results. For example, failures should never occur where the housewife understands and makes use of the devices for indication and control which may be obtained with an electric range.

As it is not always possible to secure a decision as to the extent to which efforts will be made to develop an undertaking it is often extremely difficult to forecast with any great accuracy the probable "shape" of the load curve.

For the purpose of analysing the merits of the alternative plants available, however, the following has been taken as a typical case for the purpose of this paper :—

It is assumed that the load commences to rise steeply towards the peak at say 5 p.m. and by about 6 p.m., a peak of 7 kW occurs. Street lighting would contribute approximately 1½ kW to this peak and it may be assumed that with street lighting maintained from say 6 p.m. to 11 p.m., the load on the plant by 9 o'clock will have dropped to approximately 1¾kW. From 11 p m. till 5 p.m. the following day the average load may be taken as about ¼ of a kW, though there is no doubt loads of the order of 1 kW will be likely to occur for short periods.

If a curve of this nature is summated it will be found that the total units sent out would be of the order of 24 units per day or an average load of 1 kW. The load factor of the undertaking assumed would therefore be about 14%, which for purely lighting schemes such as that visualised, may be somewhat high. This indicates that, on the basis of a peak load of 7kW, the peak load period in the foregoing assumption is more protracted than may be expected in practice.

With the development of the undertaking it would be reasonable to assume that the off-peak load would increase to a somewhat greater extent (by proportion) than the peak load, that is the load factor would improve, but an improvement beyond 20% would indicate fairly extensive use of electricity for domestic purposes (unless an "off-peak" water pumping load is of appreciable magnitude).

If industrial supplies are likely to be required such as for small mills, then their load would probably exceed the normal peak load of a small town, and the revenue of the undertaking should be sufficient to enable the local authority to employ shiftsmen to take charge of the plant. Such cases, therefore, do not come within the scope of this paper.

A further characteristic which must be accepted, is that the load is concentrated in a relatively small area and that supply to distant consumers is not contemplated. If this is not assumed, it might be essential to adopt the alternating current system of supply, direct current being unsuitable for long distance transmission in the case of small undertakings at their inception.

On the basis of the foregoing, the author has formed the opinion that for the type of service required in small municipal schemes the direct current system incorporating a battery will generally be found to be preferable and for this reason this type of scheme will be dealt with first.

DIRECT CURENT SYSTEM INCORPORATING A BATTERY.

(a) Choice of size of generators :

Having in mind that the example assumes a peak load of 7 kW the plant selected would be required to meet this and should have a margin for development. The first question to decide is whether or not standby generating plant is necessary. As the type of plant under consideration includes a battery, the battery itself might constitute the standby, though its primary purpose might be to energise the reticulation system when the generating plant is shut down. It must be borne in mind that a battery should pass through a cycle of appreciable discharge and charge if it is to be maintained in a healthy state. If, therefore, the battery is to provide standby it would require a relatively large capacity to ensure that sufficient charge would remain at the end of any normal day's run to enable it to take the entire load during the peak period without excessive drop in voltage. If capacity is chosen to permit this the proportion of discharge during the day will constitute a small fraction of the battery's possible output because the majority of the output during each day occurs during the peak period. It then follows that the cycle of charge and discharge during normal operation would not effectively exercise the battery.

For this reason it seems desirable that standby generating plant should be provided, even at the disadvantage of greater capital cost of the scheme. Allowing for possible development in excess of a 7 kW peak, it might at first seem desirable to install two 10 kW generating sets as this would provide a complete standby generator at times of peak load. On the other hand, however, generating plant has an overload capacity and as the plant is to provide for possible development of the undertaking, it would be reasonable to encroach on the overload capacity during a state of emergency (i.e. when standby plant becomes necessary). Further it is reasonable to assume that the battery which should also be chosen to allow for some development, could be called upon to assist in supplying the load during the peak period under emergency conditions. With these aspects in mind, two 5 kW generators should meet the requirements.

The characteristics of the generating plant must also receive special consideration because of the requirements of the battery. This aspect is mentioned in greater detail later in the paper.

(b) Choice of Battery :

The success of the proposals will depend to a great extent on the effectiveness of the battery. If the battery is too small, it would be of no use during the emergency conditions visualised, while on the other hand if too large, the battery will not be sufficiently exercised to promote its life, and the cost of the scheme will have been increased to no advantage.

In order to arrive at the size of battery required, the possible output and loading at various stages of discharge must be considered in detail.

In the first case, therefore, the battery would be called upon to supply 105 ampere hours, and in the second case an output of say 20 ampere hours might appear sufficient. Having in mind provision of a suitable margin, it would be as well to select a 125 ampere hour battery or a 75 ampere hour battery (rated on the basis of the 10 hour rating) and probable behaviour of the battery should then be examined for verification of the selection.

The number of cells required, will be determined by the feeder voltage with allowance for permissable variation of busbar voltage and also having in mind that the volts per cell from a battery vary according to the state of discharge and the loading on the plant. It is therefore necessary to continue the study on the basis of the probable state of discharge of the battery and the loading at various times throughout the 24 hours. This examination is assisted by the reasonable assumption that the cells will be in a fully charged state shortly after the end of the peak period, as normally the generating plant will operate at times of peak load and when current is available will charge the cells, the charge continuing to completion in view of the relays installed on the switchboard for this purpose.

On the basis of the loading assumed, the output in both units and ampere hours taken progressively from the commencement of the low load period are set out in the following table :—

Time :	Total ampere-hours sent out:	Total units sent out :	Current loading :
11 p.m. (commencement of low load).	0	0	1 ampere.
5 p.m.	20	4.5	,,
6 p.m.	35	8.0	30 amperes.
7 p.m.	53	—	22 ,,
8 p.m.	71	—	14 ,,
9 p.m.	91	21.0	7 ,,
11 p.m.	105	—	7 ,,
11 p.m.	105	24.0	1 ampere.

As regards battery output, two conditions apply:

(1) that the battery should be capable of supplying the entire requirements for 24 hours to meet emergency conditions, and ;

(2) that the battery is only required to carry the output during the load period with a margin for assistance of the generating plant at times.

On the basis of the general characteristics of the two types of cell normally available, namely, lead acid and alkaline types, the table attached as Annexure I has been drawn up to show the volts per cell at various times throughout the 24 hours for the conditions assumed, and at the same time a column is added to the table to indicate the number of cells which would be required to be connected across the feeders to maintain 230 volts across the busbars.

In practice the end cell switching arrangements devised to connect the requisite number of cells across the feeder for the varying cell voltage conditions would provide for cutting in or out equal groups of cells, which introduces voltage variation on the busbars. Provided this variation is kept within reasonable limits of, say, approrimately plus/minus 3%, this practice is acceptable as the the expense of switching for cutting in or out individual cells would far exceed the value of the advantage of very close regulation obtained.

On the basis of the end cell switching arrangements permitting a voltage variation of approximately 5% from the assumed standard pressure of 230 volts, at the power station, the end cell blocks should at no time be subjected to a voltage of more than, say, 13 volts under all normal operating conditions. The highest voltage per cell is experiencd at the end of the normal charging process; this voltage establishes the maximum number of cells which may be incorporated in one block.

On the basis of 2.65 volts per cell for lead acid cells, 4 or 5 cells per block would be permissable whereas for the alkaline type of cell on the basis of a voltage of 1.86 volts at the end of the normal charge, 6 or 7 cells would be permissible per block.

The table in Annexure I forms the basis of the selection of the total number of cells. It will be seen that on the basis of the minimum busbar voltage and the minimum permissible cell voltage, 121 lead acid cells or 207 alkaline cells would be required. The minimum cell voltages mentioned, however, are based on a relatively high rate of discharge and these figures would be too low for a small discharge rate.

It is evident that the lowest permissible voltage would occur on high loading if a 75 ampere-hour battery is used and therefore the full number of cells may be used without fear of incurring the risk of an over-discharged battery. In the case of the larger battery, however, even the peak load on the plant will not produce the minimum volts permissible per cell, though a 24 hour discharge will completely discharge the battery. It is therefore desirable that the number of cells should not appreciably exceed say, 118 lead acid type or 184 alkaline type, corresponding to minimum cell voltages of 1.9 volts per cell and 1.22 volts per cell respectively.

In each case the total number of cells will be established by the fact that the minimum number of cells (selected for the highest voltages per cell at end of charge) will have added to it in series predetermined "groups" of end-cells.

The minima shown in the table are 90 lead acid and 127 alkaline cells respectively and, assuming groups of end cells containing 4 lead acid and 6 alkaline cells, the suitable total number of cells would be :

(a) 75 ampere hour lead acid 90 + 8 × 4 = 122 cells

(b) 75 ampere hour alkaline 127 + 13 × 6 = 205 cells

(c) 125 ampere hour lead acid 90 + 7 × 4 = 118 cells

(d) 125 ampere hour alkaline 127 + 10 × 6 = 187 cells

It will be found in practice that there is a critical number of cells such that the majority will be well used but the last block little used owing to the rapid drop in voltage as the peak load comes on. For this reason the number of cells mentioned above would have to be examined from this aspect.

A further feature which must be accepted is that, at the end of charge, the voltage must be allowed to rise above the normal maximum in order to trip out the generators at this stage and not at normal transitions of the end cell switchgear at an early stage of charging.

The foregoing analysis shows that if the battery is one which is to supply the entire output for 24 hours in emergency (after receiving a complete charge), normally the generating plant will start up nightly (by a "load relay") and will remain in service throughout the peak period, the total discharge from the battery under these conditions would only amount to the discharge during the low load period plus a short discharge as the load rises steeply towards peak (excluding the discharge required to start the generator which is small). Actually the total discharge would be 20 to 25 ampere hours, and with say a 125 ampere hour battery, this would mean that the cells would only be exercised to the extent of approximately a 20% cycle. This would not improve the performance of a lead acid type battery and would probably result in considerable loss of capacity in the case of an alkaline type.

Whilst it might at first appear that a 25 ampere hour battery would suit the conditions as regards "cycle," it would probably be too small to start up the generating sets and would be unable to assist the generators to any extent should such an emergency occur. The battery must, therefore, have a capacity between 25 and 110 ampere hours. To provide for the increase in demand which accompanies the progress of an electricity undertaking, a battery of the order of 75 ampere hours capacity is probably the smallest which would meet the requirements of the above example quite satisfactorily.

During normal conditions of working the table (Annexure I) indicates that the battery would be exercised to the extent of 33 to 35% of its capacity, and with development of the undertaking, this use might increase to approximately 50% of its capacity before extensions of generating plant necessitate the abandonment of automatic operation in favour of an attended station.

Three further features of the batteries which are of importance are :—

1. The electrolyte should not be allowed to fall below the level of the top of the plates. "Drying out" of a portion of the plate in a lead acid type reduces the

life of the section affected though the capacity is not seriously impaired. In the case of the alkaline type, however, the dried active material cannot be restored to activity and the section affected is lost permanently with resultant loss of capacity.

2. The alkaline type is most seriously affected by high temperatures and, it is frequently claimed, requires more distilled water "for topping up" than the lead acid type, particularly under the high temperature conditions met in South Africa.

3. The alkaline cells must each be insulated for normal total voltage as the cells are conductors, whereas this is not necessary with the lead acid type, the containers being of insulating material.

(c) Generating Plant Characteristics :—

The current/voltage characteristic of the generating plant is of importance in its relation to the type of cell selected.

In the case of the lead acid cell it is desirable that the charging rate should be reduced as the fully charged condition is approached in order to reduce the violence of gassing and "scrubbing" of the plates. On the other hand, in the case of the alkaline cell it is an advantage to have a high charging rate as this maintains the capacity of the cell, loss of capacity accompanying continued low rate charge and discharge cycles.

The alkaline cell does not however accept any charge when small currents are passed through it, whereas any current, however small, passed through the lead acid type of cell, produces the necessary chemical reactions for "storage" of the charge.

Certain plants are designed to incorporate "constant current generators and others provide for decreasing the voltage as end cells are cut out of circuit. In the author's opinion, the choice

between these two types of generators depends on the type of cell selected, bearing in mind that during charging there are a number of cells between the generator "input" lead and the feeder "output" lead which must carry the total load of the undertaking or the total generator output, whichever is the greater.

Where two generators are run at times of peak, the position may be eased if it is arranged that one of the two is connected direct to the busbars with suitable voltage control to avoid excess voltage. The choice of machine to be so connected should be by means of a manual preselector switch.

EFFICIENCY :

The overall efficiency of operation of the above types of plant cannot readily be arrived at by calculations in order to forecast performance, though it is probable that the operating results can be as closely forecast, almost as well as the operating results of simple generating plants.

For the purpose of comparison the following is my estimate of the annual operating cost of plant described under this section including an hour battery.

BASIC DATA :

Plant installation ..	Two 5 kW generating sets.
	One suitable battery.
	Automatic switchboard designed to start No. 1 set on low voltage or a load in excess of 2 kW and to start No. 2 set on a load in excess of 5 kW ;
	to stop No. 2 set when the load falls below 4 kW and to stop No. 1 set when the battery is fully charged.
Peak load	7 kW.

Units per diem ..	24, (say 8,600 per annum).
Hours run by each set per annum ..	Approximately 2,000 hours.
Staff	One part-time attendant at a contract rate of £10 per month.

CAPITAL EXPENDITURE :

(a) Network, Feeders, Buildings, etc. ..	£1,500
(b) Generating Plant including Switchboard ..	750
	£2,250

(c) Battery complete and installed—

	Acid : 125 a.h.	Acid : 75 a.h.	Alkaline : 125 a.h.	Alkaline : 75 a.h.
	£600	£350	£750	£620
Total Cost of Scheme	£2,850	£2,600	£3,000	£2,870

ANNUAL OPERATING COST :

Administration and Sundries	£36
Fuel at £7 per ton	31
Lubricating Oil	6
Waste, stores, etc.	6
Allow for R & M (including battery) ..	60
Contract Attendance	120
	£259

Capital Charges—	Acid : 125 a.h.	Acid : 75 a.h.	Alkaline : 125 a.h.	Alkaline : 75 a.h.
£2,250 at 9% ..	£203	£203	£203	£203
Battery at 15% ..	90	53	112	93
Total annual cost ..	£552	£515	£574	£555

On the basis of the suggested selection of a 75 ampere hour battery the annual cost would be :—

(a) Lead acid type .. £515 *

(b) Alkaline type .. £555

* **Note :** As the above figures are not based on actual tenders, the difference in favour of the lead acid type must not be taken as proven.

Further the same figure viz. 15% is used for both Acid and Alkaline cells because it is assumed that within about 8/10 years, development will have rendered necessary generating plant extensions leaving the battery to become obsolete in any case.

The next system to be considered in detail is the simple A.C. scheme :

A.C. AUTOMATIC PLANT :

If such a plant is to be started automatically it is necessary that the starting of the generating units should be electrically controlled and probably the simplest system of starting would be by means of a small starter battery and starting motor with "Bendix" type drive, the battery being kept in a charged state by means of a trickle charger preferably of the valve type.

As A.C. is to be supplied continuously the generating sets must run continuously. It is also desirable that a set or sets should be provided of suitable size to give effective loading on the running plant during the light load period. For the typical case assumed, however, the 5 kW unit must be regarded as sufficiently small, a lesser size being subjected to the disadvantage of probable overloads in the event of say three or four radiators being used during the day time on a cold day.

A single 10 kW unit could be installed for the peak load, but in view of the total number of hours to be run, it would be more economical to instal three 5 kW units, any two of which could be preselected to run during the peak period. If the installation comprised two 5 kW units (each to share the prolonged light load) and one 10 kW unit (for the peak) the running hours would not be equally apportioned between the three units.

The choice of three units of equal size would enable each to run for a similar period each year and it could be arranged that the set which is run for the light load period on any one day could remain in service during the peak period, a second set being brought into parallel at the appropriate time. The second set could then continue to run after the peak period and the set previously run for 24 hours could be arranged to shut down. The next set to be brought into service at the peak would be the third set of the installation, i.e. each set would be picked up in sequence at peak and allowed to run for 24 hours.

In spite of this choice of plant the generating sets will require to operate for lengthy periods on relatively light loads with consequent high fuel consumption. Further, each set would require to run for approximately 3,250 hours per annum and the life of the sets (in actual years) would not be great as cylinder liners would probably require to be renewed after about two years of service.

From the point of view of life of generating plant in comparison with an automatic D.C. scheme with a battery, the rate of depreciation would be in the ratio of more than 1.5 :: 1 and in view of the fact that the ratio of number of sets is 2: : 3 any comparison of the cost of depreciation between the two schemes would be of the order of 2.5 :: 1 in favour of the D.C. system.

Further, in view of the fact that the generating sets would be required to run continuously, it is desirable that a full time qualified attendant should be employed to take charge of the plant.

For the purpose of comparison the following is the writer's forecast of the probable annual cost of operation of this system making use of the previous basic data modified only by reason of those items which differ due to the type of plant, the modifications being :

1. Automatic equipment would be required ; to start up and parallel additional units to meet the peak each day and when the load dropped to say, 4 kW to shut down the set which had previously been

running. Automatic paralleling equipment has not been included in the estimates for the cost of the system in view of the provision for attendance.

2. In place of a contract for part time attendance a full time employee would be necessary at a salary of, say, £25 per month.

Note :—Though this salary may be regarded by some to be on the high side, it must be borne in mind that the Chief Inspector of Factories would necessarily require a fully competent person to take charge of the plant in each case and such persons cannot be obtained for a nominal salary nor is it in the interest of local authorities to attempt to do so. The probable cost of such a scheme would be :—

Capital Expenditure :

(a) Network, Feeders, Buildings, etc. ..	£1,700
(b) Generating Plant including Switchboard	900
	£2,600

Annual Operating Cost :

Administration, etc.	£36
Fuel at £7 per ton	46
Lubricating oil	12
Waste, Stores, etc.	18
Allow for R. & M.	60
Attendance	300
Capital Charges at 9%	234
TOTAL	£706 *

* **Note** : This figure is not based on actual tender prices. (The increased cost of providing regular attendant and dispensing with automatic feature would be of the order of £270 per annum).

(The increased cost of providing regular attendant and dispensing with automatic feature would be of the order of £270 per annum).

The next type of plant dealt with is the system utilising A.C. during the peak load period and D.C. for the light load period. For the purpose of comparison of such a system with the two systems already described, it is only necessary to consider the directions in which savings would be made and the directions in which cost would be increased.

The savings would arise from the lesser number of hours during which the generating plant would operate and the installation of only two generators. Further, it is unlikely that the battery used with such a scheme would be required to act as complete standby for the supply of the load throughout 24 hours of any day. As it could not be called upon to assist the generating plant, it would therefore be designed to supply the output during the off-peak period only.

A battery suitable for this purpose was shown earlier to require a capacity of only 25 ampere hours. To take care of possible development, however, it would probably be desirable to select a battery of not less than, say 30 ampere hour capacity. Such a battery would be more effectively used than the 75 ampere hour battery and would, therefore, probably give even better service.

The directions in which the cost would be increased would be in respect of the wiring of the network, having regard to the minimum size of copper conductor which can be effectively used in small town distribution networks, and secondly the cost of providing for automatic paralleling and change-over switchgear, and also special charging equipment.

For the purpose of comparison the following is the estimated cost of operation on the same basic data as previously used, but providing only for the part time services as in the case of the automatic D.C. scheme, in view of the fact that the generating plant would only be operated for short intervals each day. To achieve this, however, it would be necessary to ensure that the supply was maintained on the A.C. system of supply even during light load periods until such time as the battery received its full charge, i.e. the complete stoppage of the generating plant would require to be effected by the battery voltage.

Incidentally, a 30 ampere hour battery would require the support of a separate 'starter' battery.

Capital Expenditure :

	Lead Acid :	Alkaline :
(a) Network, Feeders, Buildings, etc.	£1,800	£1,800
(b) Generating Plant, including Switchboard	650	650
(c) Battery	250	490
	£2,700	£2,840

Annual Operating Cost :

Administration, etc.	36	36
Fuel at £7 per ton	30	30
Lubricating oil	6	6
Waste, Stores, etc.	6	6
Allow for R. & M.	50	50
Attendance	120	120
Capital Charges £2,450 at 9% ..	221	221
£ 250 at 15% ..	38	74
	£507	£543

Note :

(i) The only difference taken between acid and alkaline type is on account of capital charges, the same figure of 15% being taken because of obsolescence other than deterioration as it is expected plant would be fully attended in time.

(ii) Further, automatic paralleling equipment would be required, the cost would probably considerably exceed £2,700. Had this system shown to appreciable advantage, closer estimates of capital would have been necessary.

So far only principal types of schemes have been dealt with. There are, however, a number of modifications possible. Of these modifications, two which are applied to the direct current automatic systems are specially worthy of mention.

These modified systems dispense with end cell switchgear. In the first, the total number of cells in the battery is selected to suit the main supply voltage condition when the battery approaches the discharged state and is in need of re-charging, i.e. at a voltage of 1.8 to 1.35 volts per cell in the case of the lead acid type and approximately 1.1 volts per cell in the case of the alkaline type.

In order to reduce the voltage on the feeder system to normal when the cells are taken off charge, i.e. are fully charged, a voltage regulator, say of the carbon pile type, is used. The regulator absorbs (by IR drop) the excess voltage of approximately 0.2 volt per cell in the case of the lead acid type and 0.45 volt per cell in the case of the alkaline type. The losses in the regulator, therefore, vary from maximum of about 11% (lead acid) and 40% (alkaline) to zero according to the load and state of charge of the battery.

During the charging process the feeder circuit is connected by a manually operated change-over switch across only a portion of the battery while charge takes place on the entire battery. In order that the group of cells not connected across the feeder during the charging process should receive the same charge as the rest of the battery, it is necessary that there should be no load on the feeder network at the time and therefore this charging must take place during the lightest portion of the low load period. The generator used with this system is designed for a voltage to charge all the cells completely, i.e. about 320 volt (acid) or 345 volts (alkaline). It follows therefore that the battery capacity must be suited to supply a 24 hour cycle of load or at all events must supply the load throughout the peak period without the assistance of the generators. This system would show a small saving in capital expenditure over the first type of direct current system described, namely that which would supply the entire load (in the case of the 100 ampere capacity cells).

It would, however, have the disadvantage of introducing considerable losses and, therefore, where crude oil is expensive, would require to be considered in comparison the more elaborate type of plant on the basis of tenders and guarantees before it could be seriously considered.

The second modification is one which is more suited to the alkaline type of battery but could be applied also to a traction type lead acid battery. In this case the number of cells is chosen in the same manner as that described for the first type, but for the purpose of charging, the battery is split to two equal groups which are paralleled, i.e. the generators are connected across two halves of the total battery, the halves being parallel. At the commencement of charge this involves an applied voltage of half the selected busbar voltage (115 volts) as the generators are usually designed with a flat voltage characteristic suited to the busbar requirements. As the back E.M.F. of the cells at the commencement of charge may be of the order of 2.1 volts per cell for the lead acid type and 1.6 volts per cell in the cell of the alkaline type and the total back E M.F. is much below the generator voltage. To regulate the charging current, rheostats are inserted in series with the battery sections during the charging process. This system involves a relatively high loss during charge and requires the use of change-over paralleling switchgear to modify the battery connections to suit the alternate conditions of discharge and charge.

This modification, however, has the advantage that the generators can be used to carry the peak load of the undertaking, and therefore the smaller capacity batteries (75 ampere hour) would be quite suitable. As before, however, in view of the high cost of fuel oil, it would be necessary to consider in detail the cost of losses on the basis of tender prices and guarantees before selecting this system in preference to the system incorporating the automatic end cell switchgear described earlier.

ANNEXURE I

TABLE SHOWING VOLTS PER CELL ETC. DURING A PERIOD OF 24 HOURS.

Time :	Current Loading:	Total Ampere hours Discharged	VOLTS/CELL				NUMBER OF CELLS ACROSS FEEDER			
			LEAD ACID		ALKALINE		LEAD ACID		ALKALINE	
			125 a.h. size :	75 a.h. size :	125 a.h. size :	75 a.h. size :	125 a.h. size :	75 a.h. size :	125 a.h. size :	75 a.h. size :
P.M.			*		✱					
11.00	1.	0	2	2.	1.54	1.54	112	112	146	146
5.00	1.	20	1.98	1.98	1.32	1.35	114	113	170	166
5.30	15.5	27.5	1.94	(1.73)	1.27	(1.09)	116	—	176	—
5.45	23	31	1.92		1.23		117	—	182	—
6.00	30	35	1.90	—	1.22	—	118	—	184	—
7.00	22	53	1.92	—	1.23	—	117	—	182	—
8.00	14	77	1.93	—	1.25	—	116	—	180	—
9.00	7	91	1.95	—	1.27	—	115	—	176	—
11.00	7	105	1.93	—	1.25	—	116	—	180	—
5.00	1	125	1.98	—	1.25	—	114	—	180	—
Minimum Voltage at End of Discharge on Normal Discharge Current ..			1.85	1.85	1.10	1.10	121	121	207	207
Maximum Voltage end of charge			2.65	2.65	1.86	1.86	90	90	127	127

* This shows that to safeguard this battery time switching to start the charge would be necessary though with increasing loading to the point where the peak is approaching 10 kW the low voltage of the battery might cause the plant to start up, but it would be unwise to dispense with a time switch even at this late stage.

For the upper limit of permissible voltage.

✱ The numbers in these columns is the number of cells requir ed to secure the minimum voltage, viz. 224 volts i.e. 230 volts minus approximately 3% and allows of 236 of the maximum voltage, viz. 230 plus 3%.

SUMMARY :

From a financial point of view, the following is a comparison of the several systems of automatic plant :—

			Capital Cost :	Annual Operating Cost :
D.C. Plant	(a) Lead Acid	..	£2,600	£515
	(b) Alkaline	..	2,87	555
A.C. Plant			2,600	706
A.C. — D.C.	(a) Lead Acid	..	2,700	507
	(b) Alkaline	..	2,840	543
(Fully attended station		..	2,300	976)

It will be seen from the above figures that the non-automatic plant, whilst showing a saving in capital expenditure of £300, results in an actual cost of operation considerably in excess of an automatic scheme. The figure selected for the attended station assumes the adoption of alternating current. By adopting a direct current system incorporating a battery, an attended station would cost very little less than an attended alternating current station, but if the facility of using the battery unattended were adopted, the saving on an attended alternating current scheme might amount to a figure of £200 per annum. Such a station would still show a cost in excess of a station equipped for completely automatic operation. In the circumstances, the case has been made for the use of automatic plants, and of these, the best appears to be the direct current proposition.

CONCLUSIONS :

From the foregoing, the choice as between the several systems of supply is not an obvious one, but it would seem to the author that some preference should be given to the complete direct current system incorporating automatic end cell switchgear, should actual tenders show greater differences than estimated in this paper. The reason for the suggested preference is that such plant is likely to give the greatest satisfaction to the consumers who invariably appreciate close voltage control. The preference, however, must be assessed on the basis of annual cost.

The impression seems to be abroad that direct current has had its day, and that no new undertaking should tolerate consideration of its use. This opinion is clearly a fallacy, because there is no doubt that for purposes such as those featured in this paper the direct current system of supply is very suitable and makes possible the supply of electricity with its attendant benefits to consumers who would otherwise have to forego the use of electricity for many years. The adoption of direct current for such a purpose being decided by reason of the absence of an industrial load or distant consumers, will not involve serious amounts of "obsolete plant" if and when the change over to the alternating current system of supply is considered, as there would be no cost on account of replacing consumer's appliances.

The author would, however, recommend that in the event of such systems being put into practice, every effort should be made to facilitate the change over to the alternating current system of supply at a time when such a change over would be beneficial. Provided this aspect is taken care of, the direct current system can be installed without fear of its effect on the requirements of the future.

I must thank you, Mr. President, Ladies and Gentlemen, for the opportunity you have afforded me to present this paper, and as some may wonder wherein its subject matter is of interest to your Association, I would point out that it may facilitate the establishment of electricity undertakings which, after a space of 5 to 7 years, will require the services of potential future members of the Association. The automatic schemes described, therefore, are not likely to militate against your development, but should have the reverse effect.

In conclusion, I wish to thank the Electricity Supply Commission for having granted me permission to express my personal views to you.

The President: Thank you very much, Mr. Milton, for your most interesting paper, which I now throw open for discussion.

DISCUSSION.

Mr. W. Mail (Kokstad): When Kokstad first started 15 years ago it was practically a semi-automatic plant, as for the first two years the plant only ran five hours a day in the evening and the battery did the balance of nineteen hours. The following figures may be of interest:

Units Sold:

First Year	30,000,	plus	12,000	for	street lighting.
Second Year	54,363,	„	13,200	„	„
Year 1938	261,670,	„	61,654	„	„

The plant at the start consisted of 2-40k.W. steam sets which has lately been discarded and to-day the plant consists of Diesel Oil sets, .2 sets of 92k.W. each, one of 120k.W. and one of 30k.W., the larger sets being two-stroke and the small set four-stroke.

The Battery lasted seven years and was too small at this period, as the positive plates were giving trouble, but the negative plates were good.

The staff at the start consisted of the Town Electrical Engineer, Shift Engineer and one Apprentice, while to-day the staff consists of Town Engineer, Assistant Electrical Engineer, Power Station Engineer, Shiftman, one Improver and two Apprentices.

The tariff at the start was 1s. 3d. to sixpence per unit, while to-day it stands at 1s. to one penny per unit.

Mr. A. Heydorn (Johannesburg): It is very appropriate that Mr. Milton has continued the discussion on the use of automatic equipment for small Municipal Power Plants, since the trend of development is definitely in that direction. Much work has already been done and new applications are under consideration, so that one can say that we are on the eve of a new development in the supply of electricity for communal use.

The trend of thought in Mr. Milton's paper is that many functions, which are at present being carried out by attendants, could, by the application of modern methods of supervisory control, be accomplished by mechanical or electrical devices. Thus the -services of attendants to the power plant would not be required and through the saving in running costs, the amenities of electrical supply could be made available to small communities, which with the present method of operation would find such supply beyond the reach of their financial resources.

When embarking upon a new development of this nature, it is necessary to obtain a clear conception of the demands which have to be made upon the automatic equipment and, also, of the possibilities of complying with such demands within the limits drawn by considerations of economy and by the means available for maintaining the plant in proper working order. From specifications recently issued, it appears that opinions diverge considerably in this respect. Requirements of some specifications can be fulfilled by simple alarm devices whilst other specifications make demands which could only be met by the most elaborate equipment available. Whilst Mr. Milton has very clearly shown the economical aspects and many technical sides of automatic plants for municipal use, I should like to touch on the relation of automatic equipment to the human element which it is intended to replace.

A fact which is not generally appreciated is that, for many years already, the most difficult task for an attendant to perform, namely, regulation of fuel supply of engines and speed regulation, has been taken over by automatic devices, namely, the Governor. Also the regulation of a steady generating voltage has, in all large power stations and numerous small stations, been handed over to an automatic voltage regulator. The functions left to shiftmen or attendants are essentially of a supervisory character. Apart from oiling and cleaning, their duties include the keeping of records and watching of the machines, so that they may take action in the event of any fault developing. It is obvious that the next step in perfecting the power station equipment, would be towards the replacement of such supervisory functions by suitable devices. There is no reason why various temperatures, the flow of cooling water, oil pressures, etc., should not be checked by contact-making devices, giving a signal or an operating impulse whenever pre-determined limits are being overstepped in the operation of engines. It is a recognised fact that the operation of such devices is more reliable and more rapid than the observations of attendants usually are. Depending on the method of operation adopted, such devices could either call the person, who is engaged in some other occupation, or release some mechanical or electrical action in the station, including the shutting down of a set in case of need.

Mr. Milton, in his paper, goes several steps further than this. He visualizes the incorporation of devices for checking the load and for bringing in and shutting down sets, when the load fluctuations require this.

Mr. Milton, however, does not mention another feature, namely, that automatic sets are not as yet able to "scratch themselves" or to "wag their tails." What I mean is that there is no provision for automatic detection of or intervention in case of incipient deterioration, formation of carbon, deposit of dirt in the fuel system or scaling of the cooling water ducts, etc. Yet the functioning of the sets, particularly when automatic starting is provided, depends, to a very large extent upon perfect conditions in these respects. This is the point where the action of the human element cannot be dispensed with. The particular success with which automatically running hydro electric plants have met in this country and elsewhere, is due to the fact that water turbines have practically no tendency towards deterioration of their operating conditions.

What I further wish to emphasise is that the more perfected and elaborate automatic devices are, the more they require expert attention at certain intervals. Whilst the lower class of attendants could be dispensed with at considerable saving in wages, it would be a fallacy to assume that the qualified engineer's services are not necessary on such plants.

Coming to the particular application mentioned by Mr. Milton, namely, bringing crude oil driven generating plants within the financial resources of small villages, which could so far not afford the benefit of electric supply, it should be borne in mind that these places are usually at great distances from the larger centres, where expert assistance would always be available and that the duties of regular maintenance are contemplated to be left in the hands of the semi-skilled men available in country garages, etc.

If all features on automatic operation, which appear desirable at first sight and which are within reach of present day technical developments, are incorporated, it is possible that the class and degree of maintenance required will almost balance out the financial advantages gained by the elimination of shiftmen. It is, therefore, evident that for the applications, viewed by Mr. Milton ,extreme simplicity is an essential feature.

I fully agree with the incorporation of all devices of a supervisory character. When it, however, comes to the question of automatic starting and load control, I feel that the class of the too elaborate is already being approached, particularly if one bears in mind that maintenance of a first-class may not be assumed to be available.

In considering the question of how the station should be started one should bear in mind the nature of the load supplied in small country towns. It is characterised on the one side by a very regular load curve, which recurrs every day, so that the time of starting can be predicted almost to the minute. However, distances within the area are small, so that it is not too much to expect the person entrusted with the half-time maintenance of a station to be on the spot, when the load necessitates the starting up of another set. There should be no difficulty in assigning this duty to the attendant who, at the same time, could perform his normal operations required for keeping the machines in proper trim. If the attendant should fail in his duty and the small set should shut down through overload, this should be regarded as a very useful check on his activities.

In forming a programme for the automatic operation of power plants, it would be helpful if the members of this Association, who all have great experience in Municipal Electricity Undertakings, would during the discussion state which, in their mind, are essential and necessary features for the supervisory control.

At 11.5 the Convention adjourned for refreshments, and resumed at 11.30 a.m.

The President: We will now continue the discussion on Mr. Milton's paper.

Mr. Sparks (Pietersberg) : I was very struck by the careful manner in which the author went into details, and my first thought was that if Mr.

Milton would give such careful attention to a paper of this kind, we can be assured of his closest attention to other matters, such as our schemes for extension which have to be submitted to him. One thing that struck me forcibly in the paper was the very dangerous policy of relying on the overload capacity of a generator in the early stages of the development of a concern. We should take into consideration the lessons taught by history. We realise that in almost every case where plants are too small to take the load it has been owing to financial considerations which have not permitted of a larger plant. That brings us to the point that the financial arrangements and the principles that govern finance are not flexible enough. We seem to go along in a hide-bound way. As an example, take an extension I carried out where we wanted £16,000, of which £5,000 was for distribution. Now we all know that distribution takes a long time, and I suggested to the Council that they had better go for the whole £16,000 immediately, and that as we could not spend the whole of it at once we might invest some of it on a Hire Purchase scheme and get 10 per cent. for our money, while we were paying 4½ per cent. interest for the loan. The Provincial authorities turned it down, saying that we should borrow from our own funds. I suggest that part of the capital could be so arranged that some of the early development work might be financed out of the capital fund.

I don't think in the preparation of his automatic scheme the author has made sufficient provision for the various loads other than lighting which are likely to occur, such as refrigerators, wireless, irons and kettles, which consumers will have; in fact, I have had a case where a consumer has had a connection primarily to work his wireless, light being of secondary importance.

(Applause.)

Mr. R. A. van Ryneveld (Capetown): As a visitor I wish to thank you for the privilege of joining in the discussion on this paper, in which there are several points of particular interest to me.

But your time is short and I hope you will bear with me while I comment on one or two of the main impressions I have received.

No doubt these impressions are intended by the author to provide a basis for discussion and to bring into relief the great possibilities of Automatic Plants in small Town Lighting Schemes.

The first impression is that the plant which we have before us may be a little more automatic—and, therefore, more costly and perhaps more difficult to service and maintain—than may be altogether necessary or advisable in such small undertakings.

The second impression, which has a bearing on the first, is that there is a tendency to over-emphasise the importance of close voltage regulation and continuity of supply in small undertakings.

Please bear in mind that we are dealing with very small schemes, so that most of them are not born yet, nor will be until the author's ideas bear fruit.

It is possible to produce Oil Engine Generating Plant which will run for very long periods without attention—for as long as two months or even more. But these are tool-room jobs with very fine adjustment in everything, especially in the case of D.C. sets, as regards the balance between charging and discharging current to prevent undue deterioration of the Battery.

Such a degree of automatic working costs a good deal of money and is not necessary in the great majority of cases, nor does the author suggest it here.

Now, before going any further, I should like to refresh our memories on two or three pertinent statements in the author's paper.

Firstly, he makes it very clear that attendance cannot be dispensed with entirely. He emphasises that Generating Plant must be maintained in good order and condition.

Secondly, he states that it must be accepted that, as soon as the scheme is in a position to meet the cost of employing an operating staff, the owners will be required by law to employ such a staff, **thus rendering the automatic features redundant to a large degree.**

Thirdly, and this is important, he quotes the Chief Inspector of Factories as saying that, from the distribution aspect, it is necessary for the protection of the public that a competent person be placed in charge of all electricity undertakings, however small.

According to these very sound statements, it seems to me that it must be accepted that at least one individual—whether or not you give him the title of Municipal Electrical Engineer—must be placed in permanent charge of the undertaking, and should be a permanent employee of the Council.

The degree of competency required from such an individual would depend, naturally, on the size of the undertaking and on the nature of the Plant.

It seems, therefore, that the object of automatic Generating Plant shoud be not to eliminate the Municipal Electrical Engineer and employ contract attendance, but rather to eliminate the shiftmen during the early stages, and, at the same time, to quote your own words in your presidential address, Mr. President, to release the Engineer from some of his purely technical work, to enable him to devote more of his energies to developing the electricity undertaking as a whole, which, successfully accomplished ,would be of far greater value than the mere supervision of machinery.

Now, in the light of these remarks, and assuming that a full-time employee will always be at hand to give some little time to the Plant every day, let us examine the equipment proposed by the author.

Turning to the middle of page 167.
Features common to all schemes:
Automatic starting of the prime movers and automatic paralleling Equipment:

With D.C. Plant incorporating a Battery, this can be provided for easily ,and should not be omitted.

With A.C. Plant, which must run continuously, there is, of course, no object in providing automatic starting if automatic paralleling is not to be provided also.

Assuming, as is indicated in the paper, that the incidence of the load in small undertakings can be predicted with reasonable accuracy, it should be a simple matter for the attendant to be at the Power Station to start up and parallel the second set in good time to meet the load, and to shut it down a few hours later.

It seems to me that the cost of automatic starting and paralleling equipment, which equipment will admittedly become redundant before very long, could be spent more profitably by increasing the size of the Generating Plant, even though this may mean slightly increased fuel and lubricating oil bills in the early stages.

A $7\frac{1}{2}$k.W. Set, say, would be more able to take care of an unexpected load rush than the 5k.W. Sets given as an example in the paper, and so avoid the tripping of the circuit breaker during unattended operation during the day. Even if the breaker does trip and the supply is cut off for a quarter of an hour or so, I submit that this is not a matter of life or death in a small dorp.

In my opinion, if two or three 5k.W. Sets are sufficient for any particular village, then that village must be satisfied with D.C. and direct current automatic plant with battery should be installed.

Protection Against Failure of Circulating Water:

Thermo-syphon or assisted thermo-syphon cooling with water tanks will no doubt be used in every case. The simplest protection will be by providing a small storage tank, feeding into the cooling tanks, through a ball valve. A float switch operating on the engine solenoid switch should not be really necessary.

The next three items, excessive temperature rise of cooling water, failure of lubricating oil supply and excessive temperature of lubricating oil are easily looked after by means of thermostats and pressure switch, all operating on the engine fuel cut-out lever.

Similarly, protection against overspeed can be provided for either in the design of the engine or by a tripping device.

Protection Against Bearing Seizure:

This presents some difficulty, as it will be appreciated that it would be a very difficult matter to put thermostats on the big or small end bearings. In the circumstances, whether or not thermostats on the main bearings would serve a really useful purpose is a matter of opinion.

Particular Features of D.C. Plants:

It is recognised that the most difficult feature in an automatic set is that which regulates the amount of charge received by the battery.

The two main alternatives available in practice for terminating the charging operation are the voltage relay and the watthour meter.

The defects of the voltage relay may be summarised as follows:—

Firstly: The voltage curve of the battery has a peculiar shape which becomes very flat during the last quarter of the charging process, although the slope is not very steep anywhere.

Thus a very slight error of, say, 1 per cent. in the adjustment of the relay, or a discrepancy to this extent in the voltage of the battery, will make a great difference in the time at which the charge is cut off. For example, it may cut off 25 per cent. too early, or it may not cut off at all.

Secondly: The voltage of the battery depends on many factors beside sthe state of charge. It must be realised that the battery constitutes a resistance, and this resistance introduces a definite I.R. drop which increases or decreases the battery voltage according to the direction of the current.

Unfortunately, the resistance is far from being constant, and the I.R. drop is, therefore, affected by the following among other considerations:—

(a) By the load on the Battery or the charging current. This is usually compensated for in good sets by means of a current coil in the relay, otherwise the voltage of the battery would be completely swamped.

(b) By the temperature. Since the resistance of the Battery is largely that of the electrolyte it varies considerably with temperature. The battery voltage is affected by changes in ambient temperature, due to passage from winter to summer, or even from day to night.

(c) By the level, strength and condition of the electrolyte.

(d) By the condition of the plates. If these are allowed to become sulphated, the battery resistance goes up at once.

(e) Finally, the I.R. drop is affected by the condition of the joints. If the joints between cells are not looked after carefully, resistance will develop and increase the I.R. drop.

The result of all these variations is that the voltage relay can fulfil its functions only if its setting is constantly checked and adjusted.

Such adjustments are so frequent in practice that the so-called automatic set develops into a complicated hand-operated one.

With reference to the statement that automatic equipment should be provided for effectively charging the battery as a whole, it may be accepted that any system of automatic control, certainly at anything like a reasonable cost, cannot completely charge a battery satisfactorily.

A special boosting charge must be given periodically and this must be done by hand.

I take it that the author does not favour the use of an automatic -end cell switching device. Such a feature complicates the plant quite considerably and increases a good deal the trouble of looking after the proper charging and maintenance of end cells, which represent one of the bug-bears of battery maintenance.

It will probably be found that the extra cost of the voltage relay and automatic end cell switchgear will go a long way towards providing, as a much simpler alternative, manual operation of the voltage regulator, for as long a period every day as may be necessary during the first few years of the undertaking.

I believe that, taking everything into consideration, straight current controlled sets, without voltage relays, are the most satisfactory for installations of this nature and I might mention that this is the opinion of the Development Laboratories of the General Electric Company, Limited, who, incidentally, have no axe to grind as far as automatic lighting plants are concerned.

There are only two objections which may be raised against straight load controlled sets.

The first is that the battery may be discharged too much during prolonged light loads insufficient to start one of the Generating Sets. This could be overcome by the use of a time switch. Overcharging of the battery could be guarded against by means of an electrically controlled governor or a suitable regulating resistance.

The other objection may be the drop in the supply pressure when the generating plant is stationary. This drop would be somewhere in the neighbourhood of 10 per cent. and would occur only during periods of very light loads. It might be considered that such a variation is of no account at such time.

If the drop is regarded as of any consequence during the early stages of a small undertaking, however ,then a suggestion would be to instal a small auxiliary set of, say, one or two k.W. capacity to run either continuously or to be started and stopped by means of a time switch.

The two main generating sets would be operated automatically according to the load and generally as described in the author's paper.

In all probability the cost of such an auxiliary set would be less than the extra cost of a voltage relay and automatic end cell switching device, not to mention the extra generating plant capacity or the possible reduction in the capacity of the battery.

It would appear that, before progress can be made, the Chief Inspector of Factories, or whoever is responsible for indicating what protective equipment for Generating Plant should be provided before permission will be given for such Plant to be operated partly unattended, should be approached for a decision in this matter, so that more or less uniform specifications may be issued by the various Consulting Engineers.

It may be accepted that ways and means can be found nowadays of giving a supply of electricity to nearly every town and village in the country.

I should like to congratulate Mr. Milton on his paper and on having pointed out one of the most likely ways. If he succeeds then it will assuredly mean paradise regained for our country cousins who now live in darkness.

Mr. Bahr (Klerksdorp): Mr. Milton's suggestion was made by me four years ago, but the powers that be turned down the proposal. One most important point is that maintenance must not be neglected. The system of a robot power station is excellent, but I would not rely upon it altogether.

Mr. F. D. Opperman (Capetown): I have found all the papers very interesting but the one that interested me most was that given by Mr. Milton. It is not so long ago when it was found necessary to standardise the supply voltage and system and the present day accepted standard is 380/220-volts, three-phase, four-wire. This standardisation helped tremendously to popularise the use of electricity throughout the country as equipment was standard and always available. I wonder if Mr. Milton could tell us how many thousands of pounds it has already cost the various supply authorities to convert from Direct Current to Alternating Current?

So far as A.C. automatic plants are concerned we may consider such plants as established and here to stay, but I think the installation of D.C. automatic plants is a retrograde step.

Automatic plants should not be considered only for the possible saving of labour and neither should the labour side be the deciding factor when designing a scheme.

The most important factor in any scheme is to make the consumers electrically minded and thus build up the load, but this is hardly possible where an electrical scheme is controlled by a garage hand.

It would also appear that Mr. Milton has not given much thought to the Merchants side. Most, if not all, manufacturers of domestic electrical equipment have standardised on A.C. gear and at the present moment there are very few cookers, automatic kettles, refrigerators, etc., which operate satisfactorily on D.C. Radio, also, is more difficult to operate on D.C.

It appears to me that we are not improving matters or helping the small town consumers by giving them D.C. and forcing them to use special equipment at higher prices; in fact, this is just the sort of sales resistance which would keep a small lighting scheme back and offset the very advantages of the D.C. automatic plant outlined by Mr. Milton. This important point should receive earnest consideration.

The President: Time is going on. Mr. Swingler's paper is also down for discussion this morning, and I suggest we defer discussion on this particular subject which is of special interest to small towns until to-morrow. If you are agreeable to that, I will ask Mr. Swingler to present his paper now.

Agreed.

The City of Capetown. Hire-Purchase Scheme for the Sale of Electrical Appliances.

A Revue of the Scheme and of the Results Achieved Since its Inception on 1st September, 1930.

By G. H. SWINGLER

City Electrical Engineer — CAPETOWN.

INTRODUCTION.

A study of the annual analyses of the uses to which electric energy sold by the older established concerns shows that up to a few years ago the domestic load in most instances had grown haphazard, so that what development had taken place in that direction had been due almost entirely to the extent to which the tariff rates made electric heating and cooking more attractive than the use of solid liquid or gaseous fuel for carrying out these operations. Until the year 1930 the City of Capetown Electricity Undertaking, which serves a European population of 153,640 and whose area of supply covers 50 square miles, was no exception in this way, although it should be observed that an attempt was first made to popularise the use of electricity for heating and cooking purposes in 1912, when an arrangement for hiring out electric ranges at a monthly rental was introduced. This, however, was dropped in 1916 when difficulty was experienced in obtaining the necessary replace parts and when, because of the more or less experimental nature of the design of the apparatus and materials used for the purpose, the difficulties met with by the Department and the inconvenience experienced by the hirers were such that the scheme actually tended to undermine the purpose for which it was inaugurated.

Later, when again giving consideration to the possibilities of cultivating the domestic field for the development of the Undertaking, it was realised that for successful results to be obtained it would be necessary to reconstruct and extend the transmission and distribution systems so as to enable supplies to be given to all and sundry irrespective both of their requirements and of their location. This work, which was commenced in 1920, was carried out in such a way as to provide firstly for an immediate considerable growth in supplies for industrial purposes, and when good progress had been made with that part of the work the remainder and (because of the scattered nature of the area of supply) greater part was commenced.

While this work was in progress the interest of consumers in the use of electricity for domestic purposes for heating and cooking was aroused by demonstrations, advertisements and publicity matters of various kinds, and in the latest stage of the work a substantial reduction was made in the tariff of charges for supplies for those purposes. This and earlier reductions in the tariff rate appeared to have an effect in encouraging the greater use of electric energy for domestic purposes, and the results obtained showed clearly that a very rapid rate of growth in this direction would take place if facilities were made available whereby consumers could avoid the large capital outlay involved in the purchase of the appliance and in its installation. As the transmission and distribution systems had been reconstructed and extended to the necessary extent by 1930, and as at that time the reliability of the leading makes of domestic electrical equipment had been established beyond all doubt, the Council on the 1st September of that year inaugurated a scheme for the hire purchase of domestic electrical appliances, the success of which has far exceeded expectations.

The need for the inauguration of such a scheme to bring about an increase in the use of electric energy for domestic purposes is illustrated by the fact that although a large number of firms had for many years previously been engaged in the electrical trading business in Capetown so that there was a wide choice of appliances of various kinds and makes available to the public, there were only at the time of the introduction of the Council's hire-purchase scheme 1,501 electric ranges of 3,500-Watt and upwards loading connected to the mains, whilst electric water heaters and refrigerators, although offered for sale, were scarcely used at all.

The basic principles on which the scheme is founded are those of co-operation with the dealers and non-trading on the part of the Council. As might have been expected, serious difficulties arose in the first instance, many of which were raised by dealers who, although they had been consulted in the preparatory work on the scheme, did not understand that the Council did not propose to enter into trading competition with them. These were overcome in time so that the dealers now appreciate that the scheme is an important factor in the expansion of the local trade in electrical appliances generally.

In this connection it should be observed that although it has been found necessary, since its inauguration, to change slightly the original working details of the scheme, the fundamental principles of non-trading and co-operative working with the dealers have been rigidly adhered to throughout.

Although there was a certain amount of hesitancy in the first instance on the part of dealers to associate themselves with the scheme, when once its success had become apparent large numbers of applications were received from firms desirous of participating in it so that it became necessary at an early date to limit the number of makes of each class of appliance which would be handled under its auspices.

APPROVAL OF APPLIANCES.

At the present time the number of makes of ranges and other appliances handled is limited to a maximum of twelve. The number of makes and types of electrical appliances dealt with under the hire-purchase arrangements is reviewed annually, so that at the beginning of every year it is open to the Council to revise completely the types and makes of appliances handled.

Approval on the part of the Council to any particular type and make of appliance is determined mainly by considerations of its design and workmanship, its performance and its price, these being regarded as the essential qualities on which the degree of satisfaction obtainable in service depends and no appliance is approved until it has shown its worth either from local experience or by means of exhaustive tests carried out on representative samples by the Electricity Department. Notwithstanding the care taken in this direction, however, instances occur of appliances which fulfil all of the Council's requirements proving unpopular with consumers, and in order to ensure that consumers have as wide a choice as possible of appliances of the types which they themselves desire to use annual sales quotas have been set for the sale of particular makes of appliances as a condition precedent to them being included in the approved list for the ensuing year. The number of types of appliances of particular makes which dealers are required to sell under the hire purchase scheme in any twelve months as a condition of their being retained on the approved list is:—

	Minimum Number of Sales per Annum of each Make of Approved Appliance.
Ranges	36
Water Heaters	24
Refrigerators	18
Washing Machines	6

ARRANGEMENTS WITH DEALERS.

The consumer is at liberty to select any type and make of approved appliance handled by local dealers and upon completion of a hire-purchase agreement the Council purchases the appliance outright from the dealer at an agreed discount and recovers the selling price from the hire purchaser by instalments.

The arrangements between the Council and the dealer are set out in an agreement which is entered into for a period not exceeding twelve months at a time. As far as possible it is arranged that such agreements take effect as from the 1st January of each year, and towards the end of that year a review is made of the list of dealers with whom agreements are expiring with a view to making such changes in the ensuing year as may be considered desirable, for it will be understood that such considerations as the manner in which a dealer has complied with his obligations under the current agreement, his financial standing and his general suitability to handle goods for which the Council stands responsible to consumers are, quite apart from the inherent qualities of the appliances sold, matters of considerable importance to the success of the scheme.

On the inauguration of the scheme the agreement entered into with the dealers dealt only with the rates of discount to be allowed to and by the

Council, the commissions to be paid to electrical wiring contractors for the introduction of business, the fixing of selling prices and arrangements for servicing appliances. It soon became apparent, however, that employees of some of the dealers and electrical wiring contractors were contravening the spirit and intention of the agreement to secure business at the expense of their more scrupulous competitors, and although this led at the time to a certain amount of difficulty, not only with dealers but also with consumers, it had the result of bringing about the formation of an electrical dealers' association representing the majority of the firms dealing in electrical appliances, the existence of which has facilitated contact with such firms and has thereby made for the smoother working of the details of the scheme.

As an illustration of the difficulties encountered shortly after the inauguration of the scheme mention may be made of that which arose out of the payment of discounts and commissions. The agreement provided that the dealer grant to the Council a discount of 15% of the retail price of an appliance, and that the Council pay half of this discount as commission to any one of the registered electrical wiring contractors who had canvassed and effected the sale under the Council's scheme. He also was employed by the Council to carry out any work that might be necessary in connection with the installation of the appliance. In a very short time this practice was abused to a great extent by firms claiming commissions who had not in fact canvassed the sale at all, by firms who canvassed sales of appliances with greater regard to the relastionships between themselves and the particular dealer concerned than to the suitability of the article for its intended purpose, and by firms who had arranged to obtain commissions from dealers in addition to those granted by the Council. Moreover, information was received on several occasions that appliances were obtainable by consumers from dealers for cash at lower prices than those at which the dealer had quoted for sale from the Council's showrooms. All these difficulties had the immediate result of causing distrust of the scheme by would-be purchasers so that the Council took the first opportunity of discontinuing the payment of commissions and arranged with the dealers that they themselves would attend to the matter of commissions paid to their canvassers. In consideration of that being done a lower rate of discount was agreed upon and stringent penalties were also introduced into the agreement for evasion of its spirit and intention.

When this change in discount had been made dealers soon were paying commissions to all and sundry, and as no definite rate had been agreed upon the amount of the commission paid varied over a wide range. The canvassers in turn made extravagant promises which could not be fulfilled and offered would-be purchasers inducements of various kinds ranging from payment of the first instalment to the supply of cooking utensils in order to conclude the sale. At the expiration of that agreement the Council insisted that dealers accept responsibility for the promises made by their canvassers and an endeavour to check irregularities was made by limiting the amount of the commission payable to canvassers to 5% of the retail price of the appliances. This arrangement was also abused, and at the request of dealers who had adhered to the spirit and intention of the agreement, the agreement entered into in 1938 again omits reference to the amounts of commission payable so that each dealer makes his own arrangements in that respect. Indeed it may be said that the only real difficulty experienced in the working of the hire-purchase scheme has been the inability of the dealers to agree upon, and to adhere to, a code of sales policy, a state of affairs which has in numerous instances given rise to dissatisfaction on the part of consumers with consequent loss of goodwill between the Electricity Department and its customers.

A copy of the form of agreement now being worked to which was first introduced at the beginning of 1937 is appended marked Annexure "A", which, summarised, binds the contracting parties to the following conditions:—

1. The purchase and sale of certain specified appliances at retail prices **fixed by the dealer** and agreed by the Council.

2. The dealer may not sell to the public at a figure less than that fixed by him and agreed to by the Council as the selling price except with the written consent of the Council, provided that with the approval of the Council lower prices may be quoted in any particular instance for the sale of three or more major appliances as one transaction.

3. The Council receives from the dealer a discount of 22½% of the retail price or of the agreed lower price referred to above on all purchases made by it whether for resale under the hire-purchase scheme or sold by the Council for cash.

4. The dealer is not to give more favourable terms to any person than he gives to the Council except with the consent of the Council.

5. The Council allows on all sales a discount of 20% for cash and the dealer may allow a similar discount but not more.

6. The dealer is not to effect sales on a deferred payment basis of an appliance approved for sale by the Council under the hire-purchase scheme unless the Council has refused the business.

7. The dealer guarantees the appliances for the full period of repayment, with reservations referred to below, and must stock and provide the Council with an adequate supply of spares.

Each dealer is required to lodge security to the extent of £100 with the City Treasurer for the fulfilment of his obligations under the contract entered into with him for the sale of approved appliances under the hire-purchase scheme.

ARRANGEMENTS BETWEEN COUNCIL AND PURCHASER.

An important feature of the scheme lies in the fact that it provides for consumers obtaining the larger types of domestic appliances completely installed ready for use in their homes. It is not insisted upon that purchasers are registered owners of property, so that any consumer of electricity to whom objection is not taken by the City Treasuerer on financial grounds may take advantage of the hire-purchase arrangements. It is only where the financial standing of a would-be purchaser is such that the City Treasurer deems it desirable that a guarantee or other suretyship be provided for the due fulfilment of the terms and conditions of the agreement in respect of the payment of instalments that such guarantee or suretyship is asked for and must be approved by the City Treasurer before delivery of the appliance will be made.

The forms of agreement (copies of which are attached marked Annexures "B", "C" and "D") entered into with the purchaser are similar to those commonly in use in the ordinary course of trade of this nature and do not call for special comment.

The accounts for the monthly instalments payable for the appliances purchased are included with the monthly accounts for electric energy consumed, and in conformity with the accounts rendered for electric energy consumed the due date of payment is fifteen days after the date of rendering the account.

ARRANGEMENTS BETWEEN THE COUNCIL AND ELECTRICAL WIRING CONTRACTORS.

Any electrical installation work required to be carried out on appliances purchased under the hire-purchase scheme is carried out for the Council by registered electrical wiring contractors who have been approved by the Council for the performing of this work. The essential qualification for the grant of this approval is that the firm must be well established in business and must have the necessary apparatus and equipment for making and testing the installations. He is further required to submit suretyship to the value of £100 for the carrying out of his work to the satisfaction of the Council.

The list of approved contractors is revised at the end of each year and the name of any firm who has not carried out at least twenty-four installations of electrical appliances under the hire-purchase scheme during the year is automatically struck off to make way for others who fulfill the requirements and who during that year may have made application to be put on the list.

Purchasers of appliances for which the hire-purchase terms include installation work are permitted to select any one of these approved contractors to carry out such work, and in the event of them not expressing any wish in this connection the Council gives the work out to any approved firm whose name comes next on a roster kept for this purpose.

The installation must be carried out in accordance with a specification, a copy of which is attached marked Annexure "E", and the work is carried out at schedule rates, particulars of which are given in Annexure " F.1."

In all cases where the hire-purchase price of an electric range includes its installation a standardised metal-clad main switch and distribution board described in Annexure "G" is included in the purchase price if not already forming part of the electrical installation of the premises. The range circuit also includes a standardised metal-clad four-pin socket and plug described in Annexure "H".

All ranges which have a connected load of 3,500 watts or more are arranged for three-phase four-wire connection and are equipped with a three-foot length of flexible metallic conduit for the protection of the lead in conductors provided with a suitable means of connection to the above-mentioned plug so as to ensure that no difficulty will be found in plugging-in ready for use any such range in the event of its removal from one premises to another.

Similarly, plumbing work in connection with the installation of water heaters is carried out for the Council by approved registered plumbers at schedule rates, particulars of which are given in Annexure "F2".

INSTALLATION AND SERVICING.

The arrangements entered into with the hire purchaser include an undertaking by the Council to maintain in good condition (fair wear and tear excepted) the appliance and the installation work included therewith throughout the whole of the repayment period, except that the guarantee period for the protective coatings of appliances and ball valves on water heaters is limited to a maximum of twelve months.

Upon completion of the hire-purchase agreement and payment of the first instalment all interested parties, namely the City Treasurer, the dealer from whom the appliance is purchased by the Council, the electrical wiring contractor, the plumber (in the case of water heaters), and the divisions concerned in the work in the Electricity Supply Department, are immediately given all information required to enable them to take the necessary action. The sales division of the Electricity Supply Department is advised of the fact of the appliance having been installed and connected up, and as soon as possible thereafter a lady demonstrator calls on the purchaser to inspect it and report on its condition. Upon receipt of her report to the effect that the appliance has been properly installed and is in good working condition and in accordance with the arrangements entered into with the purchaser the sales division submits to the City Treasurer a certificate for payment of the amount due to the dealer, and the electrical wiring contractor concerned, but in the event of the demonstrator's report showing that the appliance or the installation work is in any way defective or does not comply with the arrangements entered into between the purchaser and the Department payment is withheld until these matters have been rectified. From that time until the expiration of the hire-purchase period the appliance and the installation work carried out in connection therewith are maintained in good order free of charge to the purchaser except as stated previously in regard to protective coatings, etc. The necessary spare parts for enabling the Council to carry out this part of its undertaking the agreement with the purchaser are provided free of charge to the Council by the dealers.

The visiting lady demonstrator as well as others in the Electricity Department's showrooms are qualified to give advice on the most economical method of using the appliances as well as how to obtain the best results from electric ranges, etc., and generally to assist purchasers to obtain the maximum degree of satisfaction with electrical appliances.

In order to expedite contact between purchasers and the Electricity Department in the event of the former desiring information in connection with the use of the appliance purchased, a service card is handed with the appliance to each purchaser containing its reference number, the situation and telephone number of the nearest service depot and the best means of obtaining speedy attention.

A special form is used for the purpose of recording complaints received at the various offices and depots of the Electricity Supply Department, and the essential particulars of complaints are telephoned immediately to the depot serving the area in which the defective appliance is installed. The forms are made out in triplicate, two copies being forwarded to the service depot concerned and the third to the central office of the Department where it serves as a check to ensure that all complaints are dealt with expeditiously. When the defect has been attended to the service man enters on the copies at his depot particulars of action taken and of any replacements made, one copy of which is retained at that depot for future reference and the other is forwarded to the central office for record purposes.

In order to ensure that a complete record of every event that occurs in connection with an electrical appliance during its hire-purchase period is readily available, all service reports and other documents, complaints, requests for advice or home demonstrations, etc., are filed with the hire-purchase agreement.

A final inspection of the appliance is made at the expiration of the maintenance period when any replacements or repairs which may be necessary to put the appliance into good working order are made and when this is done the purchaser is asked to sign a clearance certificate.

ELECTRICAL SHOWROOMS.

Electrical showrooms have proved to be a most valuable means of keeping consumers informed of the uses to which electricity can be put for domestic purposes. Six of these have been established in the main residential areas in the suburbs and a larger principal showroom, which occupies the ground floor of "Electricity House" comprising the offices of the Electricity Department as well as the City Treasurer's Department, is situated in the principal business part of the city. These premises serve primarily as centres for the display and demonstration of the various makes and models of appliances that are obtainable under the hire-purchase scheme and also of other electrical appliances and labour-saving devices as well as lighting fittings which are not procurable under the scheme but are available for sale for cash. All appliances on exhibition in the showrooms are loaned by the Council by the various dealers in the city.

Showrooms of this type have the great advantage to the public that consumers and prospective purchasers of appliances are by their means enabled to inspect and compare the merits of different makes and models of appliances to determine which of them best suits their requirements and purses without feeling any obligation to make a purchase, and the majority of the hire-purchase agreements are completed in those showrooms.

Their usefulness, however, is not restricted merely to sales work. All counter work usually associated with an electricity supply undertaking is catered for so that they serve also as a convenient means of imparting information to consumers concerning the use and care of electrical appliances, tariffs and activities generally of the Electricity Department. They also serve as centres for the payment of electricity and water accounts, rates and other Municipal revenues, and by this means they serve to bring all kinds of domestic appliances to the notice of many ratepayers who otherwise would in all probability not be interested in the advantages of making more extensive use of electric energy for domestic purposes.

The extent to which the general public appreciate the more agreeable surroundings of electricity showrooms than the usual pay counter of a Municipal office is illustrated by the figures given in the following tables, in which connection it might be observed that in no case are the nearest general Municipal offices more than five minutes' walking distance from the showroom and in some instances they are next door.

Receipts issued at Showrooms up to and including August, 1938.

Year.	Sea Point opened 20.1.27	Wyn-berg opened 7.2.29	Wood-stock opened 13.7.29	Strand Street opened 27.10.30	Mow-bray opened 5.5.33	Clare-mont opened 18.12.35	Salt River opened 11.2.36	Total.
1927	2,697	—	—	—	—	—	—	2,697
1928	4,824	—	—	—	—	—	—	4,824
1929	7,803	3,270	680	—	—	—	—	11,753
1930	10,703	7,222	4,612	173	—	—	—	22,710
1931	13,983	12,329	11,633	2,631	—	—	—	40,576
1932	15,623	17,182	16,920	9,419	—	—	—	59,144
1933	16,428	20,921	19,757	26,864	6,049	—	—	90,019
1934	17,760	24,975	25,752	46,077	20,235	—	—	134,799
1935	19,320	28,790	31,831	62,490	23,907	31	—	166,369
1936	18,957	32,188	30,100	77,211	25,627	11,895	15,104	211,082
1937	20,106	36,874	30,835	91,923	26,672	21,449	25,892	253,751
1938 Jan.—Aug. 8 mths.	15,410	28,428	21,292	82,929	19,839	18,407	20,593	206,898
	163,614	212,179	193,412	399,717	122,329	51,782	61,589	1,204622

Cash received at Showrooms up to and including August, 1938

Year.	Sea Point opened 20.1.27 £	Wyn-berg opened 7.2.29 £	Wood-stock opened 13.7.29 £	Strand Street opened 27.10.30 £	Mow-bray opened 5.5.33 £	Clare-mont opened 18.12.35 £	Salt River opened 11.2.36 £	Total. £
1927	7,208	—	—	—	—	—	—	7,208
1928	12,021	—	—	—	—	—	—	12,021
1929	18,455	4,933	760	—	—	—	—	24,148
1930	24,557	10,032	7,566	412	—	—	—	42,567
1931	33,122	20,053	20,573	6,603	—	—	—	80,351
1932	38,291	24,654	22,135	21,949	—	—	—	107,029
1933	40,244	30,016	28,191	66,958	11,014	—	—	176,423
1934	43,521	37,572	36,458	124,585	35,045	—	—	277,181
1935	44,898	43,610	42,818	148,888	40,739	37	—	320,990
1936	48,123	50,182	45,029	195,640	45,541	17,524	19,397	421,436
1937	48,342	59,502	47,212	225,598	48,379	31,958	30,564	491,555
1938 Jan.—Aug. 8 mths.	39,447	50,529	36,307	245,175	43,621	29,775	28,918	473,772
	398,229	331,083	287,049	1,035,808	224,339	79,294	78,879	2,434,681

SALE AND INSTALLATION OF APPLIANCES ON HIRE-PURCHASE TERMS.

Domestic electric appliances sold by the Council are dealt with under two groups, namely:—

Group "A" (Major Appliances) :

Ranges and Ovens whose retail price is not less than £10 and/or whose total connected load is not less than 3,500 watts.
Refrigerators of 3 cubic feet capacity or over.
Water Heaters of not less than **5 gallons capacity.**
Washing Machines.
Heavy Duty and Other Appliances as may be approved from time to time.

Group "B" (Minor Appliances) :

Ranges and Ovens whose retail price is less than £10 and/or whose connected load is under 3,500 watts.
Water Heaters whose storage capacity is less than 5 gallons.
Irons, Kettles, Percolators, Wash Boilers, Steamers, etc., as approved.

Appliances included under group "A" are sold under the hire-purchase scheme including or excluding installational work as may be required on the following repayment periods:—

Ranges, Washing Machines and Refrigerators	
(with or without installational work)	36 months.
Water Heaters	
(without any installational work)....	36 months.
(including only electrical installational work)	36 months.
Water Heaters	
(including electrical and plumbing instal lational work) "push through" type	39 months.
"multiple outlet" type	45 months.

Appliances included under group "B" are sold under the hire-purchase scheme over a maximum repayment period of twelve months and for these appliances the purchase price does not include any installational work, arrangements for which must be made by the purchaser.

As stated previously, the appliances sold under hire-purchase terms are maintained in good order free of charge by the Council throughout the repayment period except for the limitation of the maitenance period of protective coatings of appliances and ball valves for water heaters to twelve months.

In the case of appliances sold for cash, however, the Council accepts no obligation in regard to maintenance or servicing, this being left to the purchaser to arrange with the dealer concerned.

RANGES.

The repayment period for the purchase of ranges and ovens was originally fixed at twelve months, but after this arrangement had been worked to for about a year consumers were given the option of purchasing these appliances over a period of either twelve or twenty-four months, and as from the 12th April, 1937, as shown above, the repayment period on ranges costing £10 or more in value and/or with a total connected load of 3,500 watts and more was fixed at thirty-six months.

Monthly instalments payable on a range sold inclusive of its installation are determined by adding 15% to the ordinary retail selling price as agreed with the dealer and dividing the amount so obtained by thirty-six; thus the monthly instalments payable on a range with a selling price of £25 would be £25+15% of £25, making a total of £28 15s. (increased to £28 16s. for facilitating accounting) divided by 36, namely 16/-.

In the event of a purchaser of a group "A" range desiring to make his own arrangements for its installation, or where a suitable installation for it already exists, the monthly instalment is determined by deducting 5% from the agreed retail selling price and dividing the figure so obtained by 36. For example, the abovementioned range would be purchased by 36 monthly instalments of 13/2d. per month, making a total of £23 14s. in all, namely £25 less 5%.

REFRIGERATORS AND WASHING MACHINES.

At the inauguration of the hire-purchase scheme the repayment periods for refrigerators and washing machines were twelve or twenty-four months at the option of the purchaser, but this, as shown above, has also been brought into line with the hire-purchase period for electric ranges, namely thirty-six months.

Arrangements of the same kind as those applying to ranges were incorporated in the scheme in the first instance for the carrying out of installation work for this class of appliance which, however, proved somewhat costly, so that to meet the position a fixed charge of £2 was introduced to cover the cost of providing the necessary plug and socket outlet together with a wiring circuit up to 50 feet run. This also was found to be unsatisfactory, and under the existing arrangements, if required, a plug and socket outlet with a run of wiring not exceeding 30 feet is installed free of charge with the appliance.

The amount of the monthly instalment for refrigerators and washing machines (irrespective as to whether or not the installation of a socket outlet is required) is determined in the same way as, for example, in the case of electric ranges sold exclusive of installation work, that is to say the monthly instalment is one-thirtysixth of the amount arrived at after deducting 5% from the agreed selling price of the appliance.

WATER HEATERS.

Hire-purchase facilities were in the first instance limited to water heaters of 60 gallons and upwards capacity and the terms of purchase included or excluded the carrying out of any electrical installational work required according to the purchaser's wishes, but the latter were in every case required to make their own arrangements for the carrying out of any necessary plumbing work.

Various modifications of these arrangements were made from time to time and at present water heaters down to $2\frac{1}{2}$ gallons capacity are obtainable on hire-purchase terms but only those of 5 gallons capacity and upwards are available on hire-purchase repayment periods exceeding twelve months.

The heaters included under group "A" appliances may be either of the "push through" or "multiple outlet" type.

The standard sizes of these two types in group "A" that are sold under the hire-purchase scheme are:—

Push Through—Capacity (gallons)	Multiple Outlet—Capacity (gallons)
5	30
10	40
20	60
30	100
40	120
60	200
100	
120	

The standard size of group "B" water heater is $2\frac{1}{2}$ gallons and all water heaters included in this group are of the "push through" type.

As described on page 222, a different repayment period is arranged for in respect of these two types under group "A" appliances when the purchase price includes electrical as well as plumbing installational work.

The electric installational work covered by hire-purchase repayments includes a circuit up to 150 feet run and any wiring work exceeding that figure must be arranged for by the purchaser separately with the electrical wiring contractor.

Plumbing work covered by hire-purchase repayments for "push through" heaters includes a run of piping not exceeding 30 feet, and 150 feet of piping for "multiple outlet" types of water heaters as well, for the latter, as a maximum of three water outlet taps.

The monthly instalments are determined in the same way as applies to other major appliances. For example, when the hire-purchase price does not include the carrying out of any installation work, the total amount payable over a period of thirty-six months is the ordinary selling price of the heater less 5% divided by 36. If the hire-purchase price includes electric installational work 15% is added to the agreed selling price and the sum so arrived at is payable in 36 equal monthly instalments. Where plumbing work is also included the monthly instalment is arrived at by adding 15% to the agreed selling price and dividing the amount so arrived at by 36 and the total amount payable by the purchaser then is that figure paid monthly over a period of 39 months in the case of "push through" water heaters and for 45 months for those of the multiple outlet" type.

OTHER MAJOR APPLIANCES.

Other electrical cooking and heating apparatus which has been sold under the Council's hire-purchase scheme from time to time includes water boilers, toasters, grillers, fish fryers, percolators, steamers, urns, hot cupboards and ovens of the hotel or heavy duty type and also wash boilers and ironers for private domestic use. The terms and conditions under which these appliances are sold are similar to those applying to electric ranges.

MINOR APPLIANCES.

As mentioned previously, minor appliances, classified for hire-purchase agreement purposes under the heading "group "B" appliances, consisting of small electric ranges, water heaters of less than 5 gallons capacity down to 2½ gallons and kettles, irons, percolators and steamers, are also available for sale on hire-purchase terms with a maximum repayment period of twelve months.

In the first instance the monthly instalments for this type of appliance were calculated at the rate of 2/- per £1 of the agreed selling price of the article purchased, but at the present time the monthly instalments are reckoned at 1/12th of the agreed retail selling price, so that, for example, a kettle with an agreed selling price of £2 can be obtained for twelve monthly instalments of 3/4.

As mentioned previously, no installational work is included in the purchase price, and the maintenance and servicing work is limited to the instalment period.

It is a condition of the acceptance of these appliances for sale under the hire-purchase scheme that they are fitted with automatic safety devices.

CASH PURCHASES.

Purchases may be made for cash of any of the appliances exhibited in the showrooms, and the discount allowed for such purchases is either 20% or 10% according as to whether or not the Electricity Department assumes responsibility for the appliances.

Where 20% discount is given the Council does not guarantee the appliance or accept any responsibility in any way for it or for installing it, these being matters for the purchaser to arrange with the Dealer, and the discount is calculated on the agreed selling price.

The discount of 10% applies only to the cash purchase of an appliance dealt in under the hire purchase scheme when the customer desires the Council to assume the same obligations as would apply to the purchase on deferred terms and is

calculated on the hire-purchase price. For example, the cash payment payable for a £25 range including its installation would be:—

Agreed selling price	£25 0 0
Increase in selling price in respect of all installation—15%	£3 15 0
	£28 15 0
Less discount for cash—10%	£2 17 6
Cash payment	£25 17 6

Further, purchasers have the option, without prejudicing in any way the other provisions of the agreement for the hire-purchase of an appliance, to make payment at any time of the whole of the outstanding instalments except a single final instalment or arrear instalments, in consideration of doing which he is allowed 10% discount on the outstanding amount.

ADVERTISING.

The scheme is well advertised in monthly and weekly journals which are popular in Capetown, and extensive use is made of the daily press printed in the two official languages. Brochures are issued and advertising space is taken in omnibus, tram and railway timetables, and in the programmes of the City Orchestra and the more popular sporting events.

Slogan advertising is also employed, space for the purpose being taken in railway coaches and waiting rooms, public telephone booths, etc. Illuminated and other signs are erected at the power station and the electricity showrooms.

The newspapers publish lengthy articles on electrical matters generally and regularly make a feature of the advantages attending its application to domestic use. In these issues the Council, electrical dealers and wiring contractors occupy more than the space usually taken up in advertising matter.

Public exhibitions of electrical appliances have been organised in collaboration with the dealers and have been very useful in popularising the use of electricity in the home.

Demonstrations of cooking by electricity on the various makes of ranges sold by the Council are given regularly in the demonstration kitchen at "Electricity House' '(which also houses the principal showroom) and in suburban Municipal halls. Up to the end of August, 1938, 431 demonstrations had been given and these were attended by 21,062 members of the public

APPLIANCES REPOSSESSED BY THE COUNCIL.

It is worthy of special mention in this regard that although from time to time the Council has had to take repossession of appliances on account of the failure of purchasers to carry out their obligations under the hire-purchase agreements, the number of appliances so dealt with has been remarkably small and all, with the exception of six ranges, have at the present time been resold.

WORKING RESULTS.

That the scheme has been an unqualified success in popularising the use of electric energy for domestic purposes is evidenced by the following data relating to the first eight years of its operation, that is to say from the period 1st September, 1930, to the 31st August, 1938.

The total number of ranges connected to the supply mains at the 31st August, 1930, was 1,051, of which 989 had been sold by dealers and 62 by the Council, whilst those sold by dealers direct to consumers since that date up to 31st August, 1938, of which records are held by the Electricity Department amounted to 4,924. In all probability, however. a few have been sold for use in existing installations without notification of this having been done being passed on to the Electricity Department, so that at a conservative estimate the total sales to 31st August, 1938, by dealers direct to consumers are 5,913. During the same period, however, no less than 18,985 ranges were sold through the Council's hire-purchase scheme, and in addition 45 have been sold by the Council outside that scheme, so bringing the total number of ranges connected to the system at the 31st August, 1938, up to 25,005 at a conservative estimate.

12 months ended	Sales of Electric Ranges Total	Average per month
31.8.31	1,566	131
31.8.32	1,631	134
31.8.33	2,479	207
31.8.34	2,680	223
31.8.35	2,769	231
31.8.36	2,299	192
31.8.37	2,890	241
31.8.38	2,671	223
	18,985	198

Notwithstanding the fact that the hire-purchase scheme has been in operation for eight years, it is of particular interest to find that electric ranges are still being sold at the rate of approximately 223 per month as compared with an average monthly sale throughout that period of 198.

The total retail selling price of ranges sold during the first eight years of the operation of the scheme amounted to no less than £526,354, all of which was spent with the local dealers. The total connected load of those ranges amounted to 127,995 kw.

Of the total number of ranges sold under the hire-purchase scheme 22% were installed in new premises, 21% took the place of other electrical heating or cooking equipment and 57% replaced appliances operating on solid gaseous or liquid fuel.

An examination of the popularity of electric ranges on the basis of the retail selling price gives the following result :—

Retail Selling Price.			Per cent. Total Sales.
"Baby" Ranges	181	ranges	.95%
£10 to £14	199	"	1.05%
£15 to £19	3,068	"	16.16%
£20 to £24	4,857	"	25.58%
£25 to £29	3,921	"	20.65%
£30 to £34	3,235	"	17.04%
£35 to £39	1,552	"	8.18%
£40 to £44	1,269	"	6.69%
£45 to £50	504	"	2.66%
£51 upwards	162	"	.85%
"Heavy Duty"	37	"	.19%
	18,985	"	100.0%

The following analysis of the total number of refrigerators and washing machines sold under the Council's hire-purchase scheme from the 1st September, 1930, to the 31st August, 1938, is of special interest in view of the fact that until the inauguration of that scheme these types of appliances were scarcely used at all in the Council's area of supply.

12 months ended	Refrigerators Total.	Refrigerators Average per month.	Washing Machines Total.	Washing Machines Average per month.
31.8.31	171	14.2	14	1.1
31.8.32	196	16.3	39	3.2
31.8.33	192	16.0	55	4.6
31.8.34	253	21.1	48	4.0
31.8.35	307	25.6	101	8.4
31.8.36	415	34.6	186	15.5
31.8.37	653	54.5	684	57.0
31.8.38	850	70.8	1,664	138.7
	3,037		2,791	

At the time when the hire-purchase scheme was introduced electric energy was used to an insignificant extent for domestic water heating purposes, but, as will be seen from the following tabulation, the hire-purchase scheme has proved to be an important means of making this service available to consumers:—

12 months ended	Water Heaters
31.8.31	67
31.8.32	87
31.8.33	69
31.8.34	366
31.8.35	640
31.8.36	753
31.8.37	995
31.8.38	819
	3,796

The extent to which the hire-purchase facilities have promoted the more general use of this type of appliance is illustrated by the fact that during the abovementioned period dealers have sold direct to consumers 9,023 water heaters, making a total of 12,819 connected to the supply mains at the end of August, 1938.

The total number of appliances sold under the hire-purchase scheme together with their value and total connected load during the first eight years of the working of this scheme is a follows:-

Class of Appliance	No. Sold	Value	Loading Watts
Cookers and Ovens	18,985	£526,354	127,995,110
Refrigerators	3,037	148,302	611,930
Water Heaters	3,796	69,966	3,567,550
Washers	2,791	95,497	607,650
Other large appliances	75	2,609	347,790
"Minor appliances	2,191	4,924	2,173,740
TOTALS	30,875	£847,652	135,303,770

The extent to which the electrical trade in Capetown has benefited by the introduction of the Council's hire-purchase scheme may be judged by the fact that during the first eight years of its working the sum expended on appliances, connecting sockets and plugs, main switches and payments made to electrical wiring contractors and plumbers amounted to appropimately £923,338, particulars of which are given below:—

Cost of appliances purchased	£711,514
Paid as commission for introduction of new business (discontinued in 1933)	4,739
Plugs and switches provided—actual cost	33,397
*Payments to electrical contractors....	£155,222
*Payments to plumbing contractors	18,436
	£923,338

*Last two months partly estimated.

As compared with this sum the amount recovered together with that recoverable under the current hire-purchase agreements amounts to £959,509, giving a balance of receipts over expenditure of £36,171. This state of affairs is noteworthy having regard to the fact that at the end of the first twelve months the expenditure on appliances, installation work, etc., exceeded the accrued revenue under the hire-purchase agreements by a sum equivalent to 14/11.3 per k.W. of connected load, while in the second and third years this figure was reduced to 7/9.5 and 5/9.8 per k.W. respectively. During later years the accrued revenue slightly exceeded the total expenditure on appliances and the cost of their installation but this did not include such expenses as the cost of servicing the appliances, the upkeep of the showrooms, salaries and wages of employees engaged in this branch of the Department's activities, interest on accounts outstanding, rents, rates, taxes and the cost of advertising, but there is little doubt that if the working results obtained during the past twelve months are maintained the hire-purchase scheme will eventually prove to be self-supporting. In any case what net financial deficit may be shown even at the present time when taking all these items of expense into consideration may be considered a normal development expense which is fully justified by the increase in business which it brings about.

The reduction brought about in the cost per kilowatt of added connected load has been due partly to savings effected year by year in the cost to the Department of installing electric ranges through the fact that when the scheme was inaugurated the schedule prices allowed for electrical installation work were unduly high, and partly to the large increase which has taken place in the number of other appliances sold, many of which do not require the carrying out of electrical wiring work.

It should be mentioned, however, that from time to time adjustments have been made in the schedule prices allowed for electrical installation work with the object of fixing them on a fair basis having regard to the prevailing cost of material and labour employed. The fact that the cost of switches, plugs and ranges themselves has for some years past steadily fallen has also contributed to the result referred to. The average cost of installing an electric range year by year is as follows:—

12 months ended	Switch Provided.	Plug & Flexible Provided.	Payments to Contractors.	Total per Range.
31.8.31	£2 0 0	£1 16 2	£12 6 10	£16 3 0
31.8.32	£1 18 6	£1 6 1	£10 10 9	£13 15 4
31.8.33	£1 18 6	£1 2 0	£10 7 5	£13 7 11
31.8.34	£1 5 2	13 8	£ 9 11 11	£11 10 9
31.8.35	£1 4 2	12 4	£ 8 19 6	£10 16 0
31.8.36	£1 3 6	11 5	£ 8 11 11	£10 6 10
31.8.37	£1 3 1	11 2	£ 8 17 3	£10 11 6
31.8.38	£1 3 0	11 3	£ 8 9 0	£10 3 3

The average cost of installing a range of more than 3.5 KW. connected load, taken over the past eight completed years, was:—

Payment to wiring contractor per range....	£9 13 4
Cost of switch	£1 9 4
Cost of plug fitted with 3 feet of metallic flexible and nipples	17 7
	£12 0 3

The extent to which the hire-purchase scheme has assisted to build up the load of the Council's Electricity Undertaking will be seen from the following table:—

Year	Units used for All Purposes.	Units used for Domestic Purposes.	Proportion. DOMESTIC All Units.
1928	51,376,879	5,958,201	11,6%
1929	58,793,865	8,765,936	14.9%
1930	65,171,659	12,430,042	19.1%
1931	78,711,163	22,002,245	27.9%
1932	91,211,052	35,036,008	38.4%
1933	105,494,807	48,720,653	46.2%
1934	123,549,763	63,680,831	51.5%
1935	144,528,954	81,005,275	56.0%
1936	167,568,745	97,883,501	58.4%
1937	192,333,625	114,691,580	59.6%
1938	(est.)213,000,000	129,000,000	60.6%

From the table it will be seen that whereas in 1929 only 14.9% of the total sales of electricity were sold for domestic purposes, this percentage has risen to 60.6% at the present time, and the actual quantity sold for domestic purposes has increased nearly fifteenfold from 8,765,936 to 129,000,000.

Since for many years the whole of the industrial requirements for power, and which are increasing relatively slowly, have been provided from electricity obtained from the Council's undertaking, the increase in the total output of the undertaking is being maintained to by far the greatest extent by the growth that is taking place in the use of electricity for domestic purposes.

The growth in the domestic load made it necessary to increase the installed plant capacity of the power stations from which the supply is given in Capetown and district from 60,000 Kw. to 120,000 KW. during the period 1932 to 1937 and has made it necessary to construct a new power station to be put into service during 1938 which will increase the installed plant capacity by a further 90,000KW. approximately.

At the end of August, 1938, the number of domestic consumers connected to the Council's system was 37.728, and the average consumption per domestic consumer, exclusive of the use of electric energy for water heating purposes, is approximately 4,000 units per annum. If water heating supplies were included, as in the case of a fully all-electric house, the average annual consumption would amount to at least 9,000 units. The difference between the average consumption per domestic consumer and the consumption by those in all-electric houses indicates clearly the scope for increase in the sales of electricity for domestic purposes apart from increases which will be brought about through further sales of heating and cooking appliances. The scope for these is found in the shortage of accommodation for the population as evidenced by the present-day building activity apart from the fact that only approximately 25,000 consumers out of 37,728 domestic consumers connected to the mains at the present time have installed ranges and only, say, 13,000 of these have installed water heaters. Whilst it is too much to expect that the present-day high monthly average of sales of electrical appliances can be maintained for all time, it is felt that on these considerations a very considerable increase in the use of electric energy may be expected to take place year by year for a number of years to come.

ANNEXURES.

(Copies of the Annexures referred to are obtainable from the City Electricity Department, Capetown.)

Annexure "A"—Agreement with dealers for year 1938.
"B"—Agreement with purchaser for ranges and kettles, etc.
"C"—Agreement with purchaser for refrigerators and washers.
"D"—Agreement with purchaser for water heaters.
"E"—Specification for installation work.
"F1"—Schedule of rates for carrying out electrical installation work.
"F2"—Schedule of rates for carrying out plumbing installation work.

"G"—Specification for electrically operated water heaters for which hire-purchase facilities are granted.

"H"—Specification for standardised main switch and distribution boards.

"I"—Specification for plugs and sockets for ranges.

DISCUSSION.

Councillor Naeser: When you resell apparatus which has been already in use do you guarantee it to be in order?

Mr. Swingler: Yes, we maintan it for three years.

Mr. Bahr: How do you deal with the owners of wireless sets, washing machines, etc.?

Mr. Swingler: We do not have any trouble from modern washing machines or wireless sets. We have no difficulty that way.

Mr. Milton: There are two points that might be brought out. In the smaller municipalities there is one. What is the effect upon the installation of plant? Secondly, the necessity for satisfactory service by the suppliers of wireless sets. I would like Mr. Swingler to enlarge on that.

Mr. Swingler: The load factor of the domestic load is much higher than I thought it would be. The load represents 60 per cent. of the total, and whereas the load factor was 40 per cent. eight years ago, and it is still 40 per cent. to-day, notwithstanding the huge increase in the sales of electric energy for domestic purposes of from 15 to 60 per cent. of the total. Climatic conditions and the habits of people make a lot of difference to the possibilities of development of the domestic load, so that one should not be dogmatic. As far as the load is concerned we have connected up 135,000 kilowatts under our Hire Purchase Scheme to date, and are continuing to do so at the same rate. We have no difficulty with reputable dealers and manufacturers in regard to guarantees for servicing the appliances. The modern stove is a very different proposition to what it was a few years ago; it is now a very reliable apparatus.

Mr. Berry (S.A. Lamp Association): I have been very interested in Mr. Swingler's paper and in his subsequent remarks, particularly in regard to the question of service given. It is most important to have a satisfied consumer, and the better the service he gets the better it is for both parties.

Mr. Seller (Boksburg): The notes by Mr. Swingler have been very interesting indeed. The chief point that strikes me also is that of service. I would very much like Mr. Swingler to tell me whether in the event of a failure of supply he goes beyond the Council's rules and sends a man to the consumer? In regard to load, I would like to know at what period of the 24 hours does the peak load occur in Capetown?

Mr. Swingler. In reply to the question about the peak load, we have a peak dependent upon climatic conditions. In winter we have an overlapping peak of 15 per cent. If we have a very wet and dull day, we would have a peak about mid-day that will equal our evening peak.

We do not compete with the contractor if we can avoid it. We seek co-operation ,not competition, and would do anything within reason to avoid consumers being inconvenienced by even partial failure of supply. Our men are on duty day and night, and we make no charge for this service. The essential consideration in the matter is that the Department is not doing anyone else out of a job, in carrying out instructions we give the consumer a reliable and effective supply. We had a lot of opposition to our showrooms at first. I myself was formerly opposed to additional showrooms, but the public demanded them, and we have established them mainly because of the service they give the public. When I tell you that in 1939 we will sell 230 million units as compared with 59 million units ten years ago, you will appreciate how the people of Capetown are becoming electrically-minded, and moreover this progress will keep going on like "old man river."

Mr. Swingler: As soon as consumers electrify their houses, you will sell ten times as much energy as before. The revenue depends upon the type of consumer. If you run a small undertaking, get the people to buy a refrigerator, and once they have it they will never be without it.

Mrs. Alrick (Capetown): Speaking of service, it was in this regard that I first approached Mr. Swingler. For years I pegged away in the direction of getting him to impose a small charge first, but I made no impression upon him whatsoever. He has met the position by insisting upon the best equipment and giving good service, and I am pleased to admit that all the way through Mr. Swingler was right in regard to not making a service charge. (Applause.)

The President: I am sure it is your wish that I should thank Mr. Swingler most sincerely, and to congratulate him upon the remarkable success of the Capetown undertaking. (Applause.)

The Convention adjourned at 1.5 p.m.

FRIDAY, 9th December, 1938.

The Convention resumed at the University Buildings, Stellenbosch, at 10.30 a.m. on Friday, December 9, the President in the Chair.

CIVIC WELCOME.

Councillor A. H. Bosman, Mayor of Stellenbosch: Ladies and Gentlemen,—I am very pleased indeed to have the opportunity of welcoming you very heartily to Stellenbosch. Stellenbosch regards it a great pleasure to be allowed to extend hospitality to the delegates of a Congress representing a profession which plays such an important part in our lives to-day. I make bold to say that in no other sphere of modern engineering and technical work has there been such astounding progress and development. In the course of practically a few years things have been put into practice which appeared even in our lifetime to be merely fantastic dreams. To-day science and the knowledge of the practical electrical engineer have brought into our homes, factories, workshops and laboratories the use of electricity in such a manner that the layman can have all the comforts and benefits therefrom in full safety and by the simplest means. All of you who devote your lives to the generating and distribution of electricity or to research in regard to electricity, to inventions and improvements, and also to the economical aspect, have a task to perform which needs knowledge and a great deal of thought and brains. I can, therefore, assure you that this visit of representatives of the profession of electrical engineers is highly appreciated and regarded as a great honour by us.

I should like to take this opportunity of making particular mention of the excellent services which the Council's electrical engineer, Mr. D. W. Ritson, who is no doubt well known to you all, has rendered the municipality of Stellenbosch. Mr. Ritson has seen what the Council considers a very successful development of an Electricity Undertaking for a town of the size of Stellenbosch, and the Council gives him the credit in this matter which he deserves. What has particularly pleased us is the generous way he acknowledges the manner in which those in authority with the Electricity Supply Commission and the Capetown Municipal Electricity Department are out to advise him, and to place at his disposal that great knowledge which they are privileged to acquire in a city like Capetown, with its manifold problems.

To give you an idea of our local progress I would like to mention the following facts. The electric lighting scheme was commenced in Stellenbosch in 1914. The plant then consisted of two 60 horse-power Diesel engines with a battery. In 1920 an additional 80 horse-power engine was erected. In 1929 a complete change over from D.C. to bulk supply was undertaken, and from then good progress has been made in the sale of units, due no doubt to the fact that we can purchase cheaper than generate. A few figures will give an idea of the progress made. In 1922 we generated 165,720 units; in 1930 we purchased 713,417 units, and in 1938 we estimate purchasing 2,360,000 units. (Applause.) In one month, August of this year, we purchased 246,000 units against 165,720 units generated for the whole of 1922. The generating costs in 1922 were 3.6d., in 1930 1.28d., and estimated for 1938, .77d. per unit. Our industrial units sold were only 259,000 for 1937, and I am sure you will agree that our progress is very satisfactory, being practically a domestic load supply. I may add that we have paid for out of revenue, the most of our change over, being £4,500, and the construction of a 3,000 volt ring main with transformers, etc., and for other improvements at different times.

I am afraid I have been taking up too much of your valuable time. Only one thing more. On behalf of my Council I wish to express our sincere gratitude to the University of Stellenbosch, and especially to the Rector, Dr. Willcocks, for his kindness in allowing us the use of this building to-day, and for the generous way in which they are always willing to help us when we need their assistance. I can assure them we appreciate their co-operation very much. Further, I wish to thank Mr. and Mrs. Farran for their kindness and the willing way in which they consented to undertake the supplying of refreshments this morning. I regard their assistance as a great favour.

In conclusion, I again wish to extend to you all a very hearty welcome to our town, and to express the hope that you will spend a very pleasant day under our shady oaks. (Applause.)

The President: Mr. Mayor, ladies and gentlemen, of Stellenbosch,—On behalf of the Association I thank you very much indeed for the very kind words of welcome which you have expressed on our visit to Stellenbosch. I would like to tell you how very interesting we have found your remarks generally, particularly your references to the progress of electricity and the useful services it is rendering to the community. I would take this opportunity of congratulating you on the remarkable progress that has taken place in connection with your electricity supply and the town of Stellenbosch itself. (Applause.) As you have observed, this is very largely due to the excellent work carried out by your Municipal Electrical Engineer. (Applause.) When some 16 years ago the Association last held its Convention in Capetown, the Stellenbosch Municipality was good enough to invite it to spend a day in your town, where, as is going to happen to-day, a paper was read. At that time it was read by Councillor Cluver, and ever since then the hope has been voiced that the members would have another opportunity of visiting Stellenbosch. You will understand, therefore, the pleasure we felt at having an invitation extended to come here to-day. That we are very glad to have come is indicated by the large number of members and friends here to-day, and who have been partaking of your generous hospitality. I would like also to thank the Town Clerk and others who have been so helpful to me personally in regard to making the arrangements for our visit. Finally, Mr. Mayor, I wish to express on behalf of the Association their sincere best wishes for the future of Stellenbosch. (Applause.)

Business was resumed at 11.15 a.m.

The President: The first business is the reading in extract form of a paper by Mr. Sparks, dealing with the supply of electricity in small undertakings. I have great pleasure in asking Mr. Sparks to address you.

The Management of a small Municipal Electrical Undertaking.

by L. B. Sparks, Municipal Electrical Engineer—Pietersburg.

I have purposely headed this paper "Management," we electrical engineers are always speaking about a Higher Status and constantly complain that other branches of engineering have been placed on a higher plane than our particular branch.

It is for us electrical engineers to gradually instill into the minds of the "Powers that be" that our position is equivalent to that of General

Managers of the concern. We must convince them that we have made a careful study of the supply of electricity in all its aspects, financial, technical and operative, and that we thoroughly deserve the confidence they are placing in us.

If our advice is found to be sound in all these aspects it will not be very long before we have gained their confidence and will have deserved the reputation of being good business men as well as good Engineers.

In order to gain that confidence there should be no "hit or miss" ideas in our methods, everything should be well thought out and we ought to be able to give a sound reason for everything we do.

Every scheme submitted to the Council should be dealt with in all its ramifications, financial and technical, and in its relation to the near future. Right at the outset of one taking over the responsibilities of management, one should work to fixed principles and in order to arrive at those basic principles one must in the initial stages do some hard concrete thinking, and get down to real fundamentals.

It is far better to spend a few days arriving at a definite working principle than to have a comparatively hazy notion of the matter concerned during a period of years. Rule of thumb methods should be avoided as far as possible, "History repeats itself" so it is said, and we must also study what is happening in other towns and watch the effects of the particular policies adopted.

Relationships :

As mentioned previously, in a small town personal contacts are of greater importance than in a large town, and these will be dealt with under their respective headings.

Councillors :

Successful management depends partly on the ability to manage men, and also the ability to co-operate with Councillors. In dealing with Councillors there are three main factors to be recognised :—

(1) A large number of Councillors especially those who hold Chairmanships are successful business men, they have made a success by sticking to certain recognised business principles and these principles have caused their thoughts to run in a deep groove.

Now the business of electric supply is rather modern and revolutionary, something different from their usual conception of business, and the aforementioned Councillors take a great deal of convincing as to the wisdom or otherwise of adopting a certain policy. I find that a personal chat to individual Councillors often paves the way. Many a young enthusiastic engineer has lost heart because his pet schemes have been turned down, although to him they are absolutely without a flaw. He cannot see why they don't accept his advice surely he is the technical expert. He then starts criticising his Council. Those of us who are older have learn't a bit of wisdom. There is a saying "The outsider sees most of the game," the Engineer often has his nose so close to the grindstone that his views are restricted in consequence. If your scheme is turned down check it up again, and if you find it is "just the goods," have another shot to get it through, but this time do a little propaganda work. My experience has taught me, (more particularly lately) that in one's enthusiasm, what at first seems the obvious course to adopt, has on further reflection and investigation to be considerably modified.

(2) **Councillors** like to see that they are not merely rubber stamps, and this is one of the reasons I thoroughly investigate any scheme that might be suggested by them instead of turning it down on the score that they are not technical experts. I am also in charge of the Water Department in Pietersburg, and I must admit that I have acted on one occasion with very successful results, on the advice of a Councillor who I considered had a good knowledge of the topography of the local country. While we may be technical experts there is no reason why we should not consider any suggestion from a layman.

In framing a report I have sometimes left loopholes for further suggestions purposely, so that the Councillors might feel they were helping to formulate a policy.

It is sometimes wise to invite criticisms from them on your scheme, for it helps one to check up on it. Seek the advice of Councillors more particularly on non-technical and business matters.

(3) It is unwise to bring up anything controversial on the eve of an election, you will not be thanked. Councillors at election time have my sympathy. There have been a few occasions when a firm stand was necessary, more especially in the early days. Imagine how my hair bristled when I heard this resolution at the first Council meeting I attended in Pietersburg. "It is recommended that the Resident Engineer take a "shift." "Gentlemen," I said, "You are losing £1,500 a year now. It is not wise to tie your Engineer down to any specific duty if you want to improve the present position, I must be a free agent." On another occasion within a few months of taking over, I had to tell a Councillor that I was the fourth Engineer they had had in three years, surely all of us could not be duds, and if he continued with his policy, Pietersburg would soon have had a dozen Engineers.

My relations with my Council have been very cordial and from time to time I have received sound advice from Councillors.

One little bit I will pass on which has helped me more than once, it is this—

"If a dog bites you once it is not your fault, if you let it bite you a second time it is your look out." In other words" Don't make the same mistake twice."

Staff :

It is essential to have co-operation between the Town Clerk, Treasury Department and the Engineer, but unfortunately this does not always exist. It must be remembered, these people always have the ear of the Mayor and the Chairman of Finance which two individuals carry a lot of weight in a small Council, and in Pietersburg these relationships are fortunately very harmonious.

An Engineer should be loyal to his staff if he is to expect loyalty in return. I take the view that the Council should see to it that the treatment of their Employees should be such as to enable them to become good respectable citizens, otherwise why are we on this earth ?

There should be no favouritism, no encouragement of tale carrying, in fact I have made it a rule never to ask an employee about the behaviour of his fellow employee, if I wish to find out anything, I rely on my own efforts, and the result is that my staff is a very loyal one.

Public and Consumers :

The attitude you hold towards your consumer to a great extent determines the success or otherwise of the Department, and to some extent your welfare also.

Is your attitude to be merely that of an Administrator of Bye-Laws ? When a consumer comes to you for assistance are you going to do your best to see with which Bye-Law you can smack him on the head, or is your attitude going to be, how can he be helped, in spite of Red Tape ? Interpret the spirit of the Bye-Law rather than the letter and take the consequences. Will my Department be in a better position by adopting a certain attitude or will it suffer ? Acting on this principle usually disarms most criticism.

Avoid pinpricking your Consumers. In Pietersburg we make no charge for replacing a fuse, if a man tells us only a part of his house is in darkness we do not tell him he must get a contractor to fix it up. Immediate service is available at any hour without charge, and the public of Pietersburg appreciate it.

I am seriously thinking of suggesting to the Council that we service stoves free of charge, whether I can ever persuade them to come to my way of thinking is another matter. But the germ of the idea is this— 10% of a consumer's account each month is credited to his service account or rather as an Insurance Premium against damage to his stove. The Municipality will then carry out all reasonable repairs free. I do not say that such ideas would work in a large town, but they would certainly do so in small towns and this would help to popularise electric cooking immensely.

One great principle must be borne in mind with regard to the sale of electricity, you must make it easy for the consumer to purchase apparatus to use that electricity.

You must also enable the consumer to keep that apparatus in such good order so that he can continually use electricity.

I don't know whether you have noticed it, but in the shops to-day your parcels are no longer tied up with string but are stuck down with celotex tape. The celotex people present the business firm with a nice machine free of charge on condition they buy the tape from them. They give a customer a machine free of charge so that he can use celotex tape.

Councillors sometimes look upon the doings of the Electricity Department as bordering on charity rather than that of sound business, so I often quote them the following which I once read in the "Electrical Times,"—

> "The Newcastle Electricity Supply Coy., England (not a Municipality mind you) thought they would like to develop business in a rather poor suburb. It was reported by their experts that "Slot Meters" were just the thing. After a year's trial they found that the scheme was unprofitable. An official was sent to investigate and found that when a lamp burnt out, either the consumers had not sufficient money to buy another or did not trouble.
>
> "The Company acted on the official's suggestion that each consumer be presented with three lamps per annum free of charge, with the result that the success of the scheme was assured."

It is absolutely essential for the success of any concern that the connection or installation fee be kept as low as possible so that there should be no restriction of business. We have installed slot meters in our sub-economic houses.

The water Department in Pietersburg was losing £1,500 per annum when I took over. The poorer people were either sharing a tap between them, sinking wells or using irrigation water for drinking purposes, all because the connection fee was a prohibitive amount as far as they were concerned, viz. £3. 10s. 0d. I suggested that the Department connect up free of charge, and as a compromise we charged 10/-. The result was remarkable, our consumers increased 40% in two years. We sacrificed £3. per consumer but the assured revenue for the first year was at least £3. per annum per consumer.

This all sounds so simple but if you wished to apply the same principles in another direction, it is surprising what opposition one would have to face, because it has not been done before. As I have said previously the average business man, especially if he is getting on in years, has settled down in a deep groove.

I have done several revolutionary things in Pietersburg, and then told the Council about it afterwards. On one occasion I felt I did the town a distinct disservice and retarded the development of a certain industry by not acting on my own initiative first, instead of seeking permission. My suggestion was damned simply because as far as I could see, such a thing had never been done before. Up to the present the Administrative side has been dealt with on more or less broad lines, we will now deal with the Technical side in the same manner. These are dealt with under three heads, Power Station, Distribution, Tariffs.

Power Station :

The success of any Power Station depends on its capacity to earn money, consequently reliability is a bigger factor than mere efficiency. This is where a steam engine beats an oil engine, one is scared to overload an oil engine while with a steam engine one is prepared to take the risk.

Your inclination to take up more and more load with existing plant, depends on the faith you have in the soundness of your plant.

It is therefore of the utmost importance to have a good mechanic in your Power Station so as to relieve you of any anxiety on that side, your part in the concern is Manager. I am not saying that you should not have the ability to carry out these repairs. But your time should not be occupied with them, neither should your mind be worried with them. One clear thought out scheme of yours might be worth thousands of pounds to the

Municipality. It is doubtful whether you would be able to make a good job of a mechanical repair yourself simply because your mind will wander to other parts of the concern while carrying out those repairs.

There are some things which when viewed from a purely financial point of view, one is not justified in installing in a power Station, but if one takes into consideration the constant source of irritation the lack of them engenders, they are well worth considering. I refer more particularly to water softeners and proper scaling machines.

One of the most costly things in a Power Station to look after is the peak load, costly both in fuel and the interest on the cost of the extra plant required to look after the peak. We have tried restricted hour tariffs but have found them a constant source of irritation to consumers and also in view of the crude oil competition we have had to abandon them.

We have not been able to eliminate the peaks in Pietersburg but while we are suffering from a shortage of plant we have been able to carry a larger load than we would otherwise be justified in doing, by inserting a Clause in our tariff to large power consumers stating that between the peak hours the supply of current is supplied at the pleasure of the Council. Such a Clause would be impossible in a large town I admit, even also in a small town where the relationship between the consumer and the Municipality is not a happy one. It has been possible in Pietersburg, and this bears out my former assertion of the importance of co-operation between the Department and the Consumer.

About two months ago a bearing on our 400 kW set failed for no apparent reason, our peak load had previously reached 650 kW, our reserve plant could only supply 500 kW. We had no difficulty whatever in persuading our large power consumers to shut down for 2 hours during the peak, during a period of 5 days.

Dealing with the question of reserve plant provided, one is not restricted for space, and the cost of land and building is not too high. I do not consider it wise to scrap old plant no matter how inefficient it is, provided it will do its work when required and costs nothing in upkeep. Power Stations often become over capitalised simply because they have scrapped their old plant to install two brand new turbines, one of which will act as a spare. The correct policy is I think to install one turbine and keep the old plant as a reserve and so avoid heavy interest charges.

Power Station Extensions :

Just as much careful thought is required both in the lay out and the choice of sizes of plant as in any other branch. What appears to be the perfectly obvious policy is not always the correct policy. The usual practice in a steam station is to double up, I should prefer to double up plus 25% with the maximum efficiency of the set at 75% F.L. rating. This practice is more likely to be a correct one for steam stations simply because the larger steam units are more efficient than the small ones, but I doubt whether it is the correct policy for oil stations more especially in their initial stages when they are struggling to balance accounts. There is not such a vast difference in economy between a large set and a small set, and it is very doubtful whether the average cost of running a large set is much lower than running two small sets to suit the load.

It follows therefore that the doubling up policy may not always be the correct one.

Take an example of a small station running 2—100 kW sets which requires an extension, one engineer would advocate putting in a 200 kW set, another an additional 100 kW set only. They may both be right under different circumstances and it is possible for the installation of the 100 kW set to be the correct policy.

The working capacity of a station is determined by the amount of reserve plant, whether the larger or smaller set is installed the amount of reserve plant is the same in each case. True the capital cost per kW of a large plant might be less, but even so the struggling concern might easily become over capitalised, with no compensation in the way of increased efficiency.

Distribution :

All of us will admit, that this has become during the last few years one of the most important branches of the undertaking, and also one which in the majority of towns has been sadly neglected.

This is not a paper on **distribution** so the matter cannot be dealt with very fully, consequently only general principles will be touched upon.

High Tension Transmission or Distribution :

3,300 is the voltage usually selected for small towns in the early stages, although I see no apparent reason why this should not be 6,600 Volts, for towns usually have to change to this voltage later on, or even higher.

It is just as well therefore to order transformers switch gear and cables which can be changed from 3,300 to 6,600 Volts without much trouble, the scrapping of material later on.

At the last Conference in Durban I mentioned the extra cost is not very great, and this avoids constructing a 10 mile line 3,300 Volts to the Kuske School Farm costing approximately £110 per mile including transformer to supply the farm school with 30 kW. This line has been in operation over 12 months with only two outages which were looked after by the resetting switch. The only improvement I could suggest on a line of this nature is the insulation of the No. 8 galvanized iron wire which acts as a lightning spike as it passes by the insulators to avoid bird trouble.

The High Tension distribution should be made use of as much as possible.

Low Tension Distribution :

Pietersburg and its suburb Annadale has close on 50 miles of streets divided between a white population of 4,200 whites. The distribution is 3 phase 4 wire 380/220 with a ring main of 3,300 Volts which is to be changed shortly to 6,600 Volts, and at the same time all H.T. is to be put underground in town, for we find H.T. and L.T. on the same poles is a bit awkward at times.

The cost to lay out the whole of the town with distributors of a substantial size is prohibitive. It would mean also in the early stages so much dead capital, and yet the policy of the Council in taking all the profits in view of heavy developments in the future, is not sound. It is wise therefore to spend some of the profits each year on solid development. Our experience has shown us lately that once a line has been put up, it is very difficult and costly to change it again later on.

It is surprising to what uses electricity is put to-day, we always try and consider the people who have stoves when switching off the line to carry out alteration, and then when the line is dead, someone rings up to say that they had a patient in bed with an electric warming pad, someone was treating a damaged knee electrically, someone was in the midst of listening to some important news on the wireless, it is all very trying, and yet when the consumers come to you quering their large monthly account they say they use no electrical apparatus whatever. There was one line which was difficult to change because one woman had to warm her baby's food at 3 p.m.

precisely every day, and this had to be done with electricity although she had other methods for warming it.

While it is impossible to wire the whole town permanently, we have adopted the following policy :—

(1) All intersections wherever situated, are made permanent even though at the time the load does not justify it.

(2) Pietersburg township is laid out in rectangular blocks, one short side and one long side, the long side being two to three times longer than the short side. After careful thought it was decided it would be more economical to make the feeders permanent in those streets running along the short sides of the blocks. What might be called pioneer lines are therefore those running along the longest side of the block.

(3) Three phases are taken into the houses for stoves.

(4) Wire of 0.1 cross section is used for the feeders and 0.035 for the off shoots.

(5) 50 k.W. Transformers are employed wherever necessary.

(6) Treated wooden poles are used to keep down cost, but all intersections and terminal poles are steel.

Breakdowns :

One should always prepare alternate routes for supply in case of failure at one particular feeding point, with plenty of linking-in points, and cementless links if possible.

Regarding breakdowns, temporary repairs should be avoided, it is better to have one shut down for two hours, than two shut downs of one hour each, there is always a very great temptation to make temporary repairs and get the current on as soon as possible.

I heard of a mains Superintendent who had a great reputation for discovering the whereabouts of any cable fault when it occurred, it was really uncanny the way in which he always located the fault first shot. It turned out however, that he was the man who did all the jointing in the first instance and knew exactly where he had adopted temporary expedients.

Tariffs :

This subject will only be dealt with very briefly to illustrate the principles which have guided the writer in formulating the tariffs and these are enumerated below :—

(1) The higher the initial charge the lower can be the ultimate charge and vice versa.

(2) In a two part tariff it is better to dispense with a block of high priced units and substitute a ready to serve charge, based on either the number of rooms, floor space or valuation.

(3) It is impossible to get a tariff to suit everybody.

The reasons for sticking to these principles are as follows :—

By having a high initial tariff you ensure that every class of consumer is paying his share towards liquidating the interest and redemption charges. If your initial charges were low you would depend on some of your low priced units to liquidate the interest and redemption charges, consequently the users of Aga stoves and the like, and non-users of electrical appliances would be getting off to lightly.

The object of every Manager is to develop further fields for the use of electricity and if his initial charges are low he is definitely handicapped.

We in Pietersburg have been embarrassed on more than one occasion by neighbouring towns starting off their supply with absurdly low initial charges. These low tariffs have caused a certain amount of discontent amongst our own power consumers. We had to take a firm stand at the time, however, with the result that while these municipalities are now struggling to balance accounts, we have as the result of making handsome profits been able to reduce our tariffs even below theirs.

The question of having a ready to serve charge instead of a block of high priced units is largely psychological in its effect, if you have two prices of units the consumer naturally has his mind fixed on the high priced units. If you have 1/- units and 1d. units he will always say the price of electricity is 1/- per unit.

The main tariffs in Pietersburg are as follows :

Private Houses :

(a) There shall be a standing charge of 10/- plus 6d. for every 100 £ valuation of the house or portion of £100 exceeding £50 of the Municipal valuation of the building in which the light is installed.

(b) Every unit will be charged out at 1d. per unit. Any dwelling to the value of £1,500 and over will for the purpose of this tariff be classed as a £1,500 house.

Power Tariff—for motors over 20 H.P. :

3/9d. per H.P. per month Maximum Demand 7,500 units at 1d. per unit and the remainder ¾d. per unit.

Note. The idea of introducing ¾d. units for power is really to get in the thin edge of the wedge, for it is my intention shortly to recommend to Council that the domestic units be reduced to 3/4d. also.

All that has been said in the foregoing pages can be looked upon as so much theory, but it is the results accruing from them which count.

Some years ago when one of the Transvaal Delegates returned to Johannesburg from a Child Welfare Conference being held at Cape Town she had the following story to tell. One of the Cape Town Delegates had given a very fine paper on "How to feed growing children," you must give them this and that, but whatever you do you must not give them **tinned foods.** The Cape Town delegate took her Transvaal friend home to lunch and when she reached home all hot and bothered, the governess met her and asked what she should give the children for lunch. "Oh ! let me see, open a tin of sardines" was her flurried answer. Let us hope Engineers do things in a better way.

Judging by the prosperity of the Cape Town Electricity Supply the electrical consumers of Cape Town have not been fed on sardines, but on sound business principles, it is just as well to wind up the Paper by a very brief description as to how Pietersburg (the Capital of the North as it is called) has thrived on the principles expounded in the paper.

My relations with Pietersburg commenced in June, 1920. When I saw the place I wondered how they could pay my salary for the following conditions prevailed.

At the Power Station, there was an old 50 kW Wolff Locomobile driving a combined D.C.—A.C. Machine through a Renold chain, which was about three to four times as long as it should have been, consequently after the chain had stretched, half the power was absorbed in driving the chain. This plant lay all in pieces on the floor of the engine house. There was also a worn out battery. There was a 100 kW B. and W. boiler built in

1896, obtained from some scrap heap, the first time the tubes were cleaned we scraped them through in one or two places, apparently only the rust and scale prevented leaky tubes. The high speed steam engine used up 30 lbs. of coal per kK on the midnight shift and up to 15 lbs. on the day shift. There had been no meters in the town for nearly three months, everyone's consumption was averaged because D.C. was supplied at night and A.C. in the day time. Copper was about 2/6d. per lb. Some of the neutral wires on the distribution were No. 14 copper and when one of the live wires broke due to a loose connection we found it to be a No. 8 galvanized iron wire. The water department also came under my charge and on the day of my arrival the Pump Station was drowned out and the town was without a drop of town water for four or five days. As previously stated they had had 4 engineers in three years.

There was a loss of £1,500 on the light department and £1,500 on the water department, to-day there is a profit of nearly £5,000 per annum on these two departments, £4,000 on Electricity and £1,000 on water.

On some days we now generate over 9,000 units per day with a plant whose running capacity is 450 kW per hour, and to look after this load a 100 kW turbine is to be installed as soon as possible.

The financial result for year ending June, 1938, is as follows :—

Income £19,200. Expenditure £15,300.
Assets acquired ex Revenue £920.
Contribution to Renewals Fund, £575.
Population of the town 4,200 Whites.
There are no Gold or other Mines.

Salaries and Wages Paid :

Power Station Superintendent ..	£40 p.m.
Outside Foreman	£35 p.m.
Shiftman	£29/10 p.m.
Handyman	£20—£25 p.m.
Apprentices	£5—£15 p.m.

In conclusion I am afraid a good many of the principles enunciated here do not apply to the larger towns, but it is hoped that something has been said which will help the young Engineers in charge of the smaller towns.

The President: Mr. Sparks' paper is now open for discussion, and I would ask speakers to be brief, because we still have to deal with the discussion on Mr. Milton's paper, and also his reply.

DISCUSSION.

Mr. C. Runtzler (Port Shepstone): I wish to thank Mr. Sparks for his very interesting paper to which we have listened to-day. I do not think there is much cause of complaint as regards "Status," because this status has to be built up in a sure, if slow, way, and much has already been achieved.

As regards the points of relationship and Councillors, I think it behoves the Engineers to listen to their ideas and ask their advice, even if they are laymen, for very often they can give very sound advice indeed, and fortunate is that Engineer who has a member of his profession on the Council.

Co-operation between the heads of departments of course is absolutely essential, as also loyalty to and between the staff, otherwise the affairs of the town cannot thrive.

There is hardly any cause to criticise the author's remarks about the Power Station, but I can say I am not scared to put a certain amount of overload on any of my Oil Engines, but avoid doing so as it costs too much on fuel oil. I do not believe in having just one good mechanic on my staff, but try to the best of my ability to make every member of it, including the apprentices, as efficient as possible, and I take off my coat, too, occasionally and show them how I think a job should be done. I also take particular care of the auxiliary plant, as your Station as a whole has only an efficiency, as the efficiency of the weakest unit thereof. The best and most efficient boilers and turbo-generators are duds, if your feed pumps are such.

Tariffs are largely governed by circumstances appertaining to special conditions in each individual town. I myself feel inclined to favour the living room charge, plus a low rate per unit, as now charged by the E.S.C. on the Natal Coast. This is not too hard on the small consumer, and gives encouragement to the larger one, besides giving fair returns to the Undertaking.

If you, Mr. President and gentlemen, desire it, I can give you, though not strictly in conjunction with this paper, the progressive costs of production of the Port Shepstone Undertaking from the time, or nearly so, of its inception.

The following tabulation of unit costs for a typical oil engine generating station such as that at Port Shepstone may be of interest:—

Period of Financial Year.	Total Units Generated.	Increase Per Cent.	Peak Load.	Average Gallons of Lub. Oil Per Month.	Cost of Fuel Oil Per k.W.H.	Lbs. of Fuel Oil Per k.W.H.	Cost of Lub. Oil Per k.W.H.	Pints of Lub. Oil Per k.W.H.	Salaries & Wages Per k.W.H.	Cost of Spare Parts, etc., Per k.W.H.	Cost of Distribution Per k.W.H.	Cost of Interest and Redemption Per k.W.H.	Total Costs Per k.W.H.
1931 (7 months)	80,700	——	52	35	.605d.	.865lb.	.1536d.	.0243P.	1.311d.	.0873d.	.22d.	.89d.	3.2619d.
1931/32	181,600	22%	60	49.3	.57d.	.821lb.	.1658d.	.026P.	1.144d.	.2016d.	.191d.	.674d.	2.9464d.
1932/33	214,700	18%	70	51.7	.618d.	.883lb.	.1335d.	.0231P.	1.066d.	.1866d.	.275d.	.655d.	2.9341d.
1933/34	258,500	20%	84	53.8	.627d.	.896lb.	.1121d.	.02P.	.9543d.	.119d.	.289d.	.596d.	2.6974d.
1934/35	312,800	21%	102	56.25	.585d.	.833lb.	.0931d.	.0173P.	.94d.	.1045d.	.416d.	.498d.	2.6366d.
1935/36	356,700	14%	115	50.6	.55d.	.786lb.	.073d.	.0136P.	.77d.	.2362d.*	.32d.	.47d.	2.4192d.
1936/37	425,800	19.6%	140	33	.487d.	.7815lb.	.0406d.	.0074P.	.7d.	.079d.	.317d.	.434d.	2.0576d.
1937/38	475,000	10.6%	154	31.75	.4606d.	.745lb.	.0367d.	.0065P.	.613d.	.0811d.	.2964d.	.392d.	1.8798d.

*The High Cost of Spare Parts is due to refitting small engines with New Cylinders and Pistons.

Councillor W. G. Delport (Krugersdorp): I wish to congratulate Mr. Sparks upon his excellent paper, which has afforded me much enlightenment. I have not had an opportunity of previously attending this Convention ,and I thought I would embrace the opportunity of saying a few words, otherwise, when I go back they will charge me with having said nothing as a delegate. I quite agree with the remarks of the author concerning what engineers should do when they want anything. Engineers, after all, do know their job, while we do not really know much about it. I hope that they will continue to carry out the good work in any undertaking they may put forward. Pietersburg was mentioned by Mr. Sparks as the largest contributor of profits from electricity, but from some of the towns it is impossible to get anything or to expect anything. (Laughter.)

Mr. Swingler: In thanking Mr. Sparks for his address, the point that struck me was regarding the installation of free service meters in sub-economic schemes. I believe you can get just as good a result by charging so much per week. In Capetown they pay 1s. per week as a service charge, and 3d. for energy they may use. Any adjusting of the rent is done afterwards. My experience shows me that many people do not pay sufficient for the benefit they receive. I think it is imperative for an engineer to let his Council know exactly what he thinks and to have it on record. I do not believe in asking for £6,000 when you want £8,000. Ask for £8,500 right off the reel. I remember asking the Capetown public for £400,000 for extending the distribution system, and told them that it was only an instalment. We got the £400,000 without difficulty; indeed, the only difficulty we had in getting authority later to raise £2,200,000 for the bigger scheme was to get a sufficient number of ratepayers together to form a quorum at the statutory meeting called for the purpose.

Councillor Naeser (Boksburg): I agree with Mr. Sparks that the Engineer must take full control. There is only one head in any firm, and in a municipality that position, I take it, is occupied by the Town Clerk. Next to him comes the Treasurer, and the Engineers must take third place. Of course, the financial arrangements must be made. One other point is that of co-operation. It is not for one or other to say he is the boss. It is co-operation that must be aimed at.

Mr. Milton: May I congratulate Mr. Sparks on the paper he has presented to us. Why he should be content to "gradually instil into the minds of the powers that be" that the Engineer must be the manager of his undertaking, I cannot understand—surely this should not be a gradual process but a fact requiring to be brought home with no delay. So many undertakings are faced with difficulties which should never arise simply because they are not properly managed.

In the smaller undertakings, of course, the inability to hand over the reins of management may be due to the low rates of pay of the men placed in charge of the schemes. For an electricity undertaking to be successful, it must, like any other business, be in complete charge of a capable controlling executive. In the electricity business this requires a man with technical knowledge. Unfortunately the majority of the smaller undertakings are managed by 10 or more persons with little or no knowledge of the fundamentals that characterise the business of electricity supply.

Mr. Sparks indicates this latter aspect in expressing the view that "the business (of electricity supply) is rather modern and revolutionary." This statement can only be accepted with reservations as there is really nothing revolutionary in the principles involved once the possible variation of the items of the cost of operating the business are fully understood. I would make so bold as to say that, if an individual Councillor were to be made financially responsible for both the capital and operation of an electricity business, he would very soon appreciate Mr. Sparks' viewpoint, as he would then of necessity require to grasp the underlying principles of the business, whereas, at the moment, no matter how conscientious a Councillor may be, he must find it very difficult to get down to bedrock in electrical matters in view of the calls on his time for general Municipal services and private matters.

If those in control of electricity undertakings could only realise that its fundamental principles are the same as those underlying any successful business, but that the details are somewhat peculiar to electricity supply, much of the difficulty at present experienced would disappear.

The author's remarks in connection with the possibility that one is sometimes carried away by one's enthusiasm should be amplified. One of the fundamental requirements in the make-up of an engineer is a calm outlook and the ability to weigh " pros and cons " in the light of cold fact. I agree, however, that in endeavouring to find a solution to many of his problems the engineer gains tremendously by converse with fellow engineers and others possessing a sufficient knowledge to offer helpful criticism. On this basis, the ideas of any individual may require modification, particularly in respect of detail. I think if the author had mentioned some specific case, it is probable my views would have applied.

I agree that every suggestion towards the improvement of electricity supply, no matter from what source it comes, must be given full consideration in the light of our specialised knowledge, but it must not be considered to our shame that at times a layman is able to draw attention to some aspect which we have failed to observe.

Probably the most vital statement contained in a very useful paper is that made under the heading "Staff," where the author mentions the necessity of co-operation between the Town Clerk, Treasurer and Engineer. I would go so far as to say no business has much prospect of success where co-operation of this nature is lacking. It is very unfortunate that such co-operation is sometimes lacking in Municipal enterprise. Here again, it is possible that the Engineer is somewhat to blame because he has not been able to bring home the fact that his job is not that of a mechanic or electrician, but that of a manager of a specialised industry.

The author also deals with the service which consumers must receive and suggests, inter alia, that stoves should be serviced free of charge. It is interesting, however, to learn that 10 per cent. of the consumers' account may be credited to his "service" account as an "insurance premium" against damage to his stove. It seems to me that this is equivalent to allowing 10 per cent. discount on the normal charge for electricity supplied because a stove is installed and cancelling the discount if the special service suggested is required.

The servicing of stoves, etc., should be a condition of permission to sell in a district (approved appliances). If traders do not give satisfactory service, then in self defence, there seems to be every justification for a supply authority taking on such work departmentally.

The crux of the matter seems to be contained in the two paragraphs where the author says that "not only must it be easy for consumers to purchase electrical apparatus but consumers must be placed in a position of being able to keep that apparatus in such good order that electricity may be continually used thereby." To offer such facilities as say, hire-purchase, is not, alone, sufficient. Hire-purchase facilities can only give real satisfaction if the suppliers of the apparatus are bound to give satisfactory service, i.e., before any supplier is granted the right to supply under a Municipality's hire-purchase scheme it is essential that the Municipality should be satisfied that the supplier will give good service.

It is interesting to observe that the City of Capetown supports Mr. Sparks in regard to Municipalities providing free service, such as for example, the replacement of fuses. In the latter connection the example set by the City of Capetown in regard to the installation of miniature circuit breakers in place of fuses, might well be followed by quite small Municipalities. The period of interruption to supply caused by momentary overloads or accidents would be reduced to the length of time it takes to walk to the distribution board and reset a miniature circuit breaker.

Under the heading " Power Station " the author claims that the oil engine beats the steam engine as regards reliability, giving as his reason that " one is scared to overload an oil engine, while with a steam engine one is prepared to take the risk." The success of any power station not only depends on its reliability but on its capacity to earn money. It is the ratio of " earning " to " investment " which establishes whether or not a scheme is satisfactory. Reliability, therefore, must be considered in conjunction with efficiency and to my mind it is impossible to generalise to the extent of saying that reliability is a bigger factor than mere efficiency. Possibly my friend at Kokstad will have something to say on this point.

The author's reference to water softening and de-scalers is very welcome, much of the operating trouble experienced in this country being due to insufficient attention having been paid to the characteristics of the water to be used. I would strongly advise all engineers to make use of chemists whose services are available at no great expense. The treatment of water is not necessarily a simple matter and the use of "patent dopes" blindly, may not only be wasteful but very harmful. I do not wish to give the impression that the patent compounds on the market should never be used. They may be very effective if used intelligently, and the only guide to intelligent use is the advice of a man trained in the subject.

The author's advice in regard to the scrapping of old plant in a power station and over capitalisation on this account requires careful consideration before acceptance. In some cases it may pay to scrap old plant, and such conditions have been faced by several Municipalities with advantage. Had the author coupled his recommendation with the qualification, "if it can be satisfactorily used," then there is no doubt the advice is sound. Every case must be considered on its individual merits.

As regards the choice of size of sets for extensions, this again depends entirely on the type and size of existing installed plant and on the prospective rate of growth of load. If the suggestion to put in sets of equal size were followed on every occasion of extension, then it might be necessary to abandon plant quite frequently in the interests of more economical operation. The stage at which it becomes necessary to scrap plant depends largely on the prospective rate of growth of load and the type and size of plant installed at the time a decision is taken.

As regards the use of wood poles for reticulation and transmission, information as to the general behaviour of these poles would be of great interest. In the early stages of development of an electricity scheme, the use of such poles may help to keep down the capital investment to the advantage of rapid development of the undertaking.

Opinions, at the moment, seem to differ widely on this subject. It may be that trouble, if any, is regional and if so, it may be possible to determine the territory within which wood poles can be relied upon to give satisfactory service.

In some cases the insulators are mounted one above the other on swan necks attached to the wood. This method of mounting may not prove entirely satisfactory, as I understand that there is a tendency for treated gum poles to twist under varying atmospheric conditions. If this twisting is appreciable the rotary displacement of the conductors around the axis of the pole would have serious consequences. On the other hand, if cross-arms and saddles are used, the nuisance of twisting could be obviated to some extent by an adjustment of cross-arm position, but this can only be regarded as effective if the twisting is slow and/or say, seasonal.

The author's suggestions under "tariffs" might well be closely studied by many engineers. There is no doubt that incorrect tariffs have resulted in stultifying development of several electrical schemes in this country. The offer of prices much above the cost of production has often resulted in profitable business being turned away.

It is rarely realised that the over-pricing of electricity will produce quite as harmful results as under-pricing, and in neither case is it likely that an undertaking will pay its way. All too frequently the average cost of production is used as a basis for determining the minimum price at which units of electricity can be sold with advantage to the seller. The fact that the cost of production is made up of fixed costs and variable cost is frequently overlooked. A review of these items would take too long but I would advise the Councillor members to study these details. In many cases, for psychological reasons, it is necessary to transfer a portion of the "standing charge" to the "unit rate" as an extremely high standing charge, even though coupled to a very small unit rate does not encourage all consumers.

I quite agree that the inclusion of a high unit rate in place of a "service charge" plus a low unit rate is apt to create discussion on the lines suggested, viz., "that electricity costs us 1s. per unit at ———." On the other hand, if undertakings have been operated on this form of tariff, it is not always a simple matter to educate ratepayers and consumers into accepting a service charge of, say, 3/- per room with a flat rate of 1d. per unit as having a lower incidence than a tariff of, say, four units per room at 1/- and the balance at 1d. per unit. Incidentally, a tariff based on a service charge may require, as an alternative, a flat rate of, say, 1/- per unit with a designed minimum comparable with the minimum available on the service charge tariff. The alternative is necessary to meet the condition of relatively large houses where electricity is used for lighting only and even then to a very small extent. In the Commission's experience the number of consumers who avail themselves of such an alternative is a very small percentage of the total number of consumers supplied on the service charge basis, but it must be admitted that electricity should be available to all potential consumers at a reasonable price.

The author indicates the difficulty some Municipalities are faced with when a neighbouring Municipality introduces more favourable tariffs than their own. This is a condition which must be faced just as, for example, geographic position is faced. The subject of tariffs is a difficult one as the allocation of costs amongst consumers is, to some extent, arbitarary. As output increases, the annual cost of operating a normal electricity scheme does not rise as a smooth curve or a straight line. The curve actually includes "steps" which occur on each occasion of the expenditure of additional capital or the completion of redemption of loans. Generally spaking, it is wise to face a small loss at the commencement of a period between extensions, provided the tariff will result in an accumulation of equivalent profit during the latter portion of this period. The accumulated profit should be more than sufficient to offset the previous accumulated deficit, in order that satisfactory reserves may be established.

The general tendency is to attempt to frame tariffs which will result in costs being met at all times. If a longer view is taken, however, there is no doubt that the improvement in the rate of load development is more benficial to a Municipality; that is, low tariffs will be more effective in developing a town economically than high tariffs designed to meet cost from the outset.

I hope I will not be taken to task if I mention that in a recent case where a scheme has been in operation for a little over 12 months, a surplus resulted although the tariff applied at the outset was 2/- per room and 2d. per unit. Though I have quoted this case I do not wish it to be taken that I am in favour of the actual amounts mentioned. Incidentally, the scheme was inaugurated to supply approximately 80 consumers and the capital expenditure amounted to approximately £3,500.

In the case of really small undertakings it is possible that the unit rate should provide a substantial contribution to the standing charges because the installation of such items as, say, stoves, may result in a relatively large increase in the on-peak demand which may lead to extensions in the power station and in the size of distribution copper required without any return from the " service " charge rates.

The author states that his remarks (preceding the stage where he quotes the tariffs at Pietersburg) can be looked upon as so much theory. I do not agree, the difference between " theory " and

" practice " in cases such as these being, however, difficult to define. To my mind he should have said that the foregoing pages of his paper could be looked upon as " so much fact " with more justice to the views he has expressed. The layman regards a theory as something which remains to be proven and as something on which little credence can be placed. The theories " have been proven and have become in fact " accepted theory " or " technics."

When submitting the financial results for the year ending June, 1938, it would have been interesting had the income been sub-divided to show how much came from ordinary domestic users and how much from commercial users. At the same time the expenditure might well have been sub-divided to indicate the cost of coal, capital charges, generation, distribution, management, etc., separately. Further, the statement that over 9,000 units per day are generated might have been amplified to indicate the total number of units generated and sold for the year he mentions—perhaps the author will be good enough to let us have these figures in his reply.

I thank you, Mr. President, for having permitted me to express my views and once again may I congratulate the author for dealing with a difficult subject so freely.

Mr. Bahr (Klerksdorp) On this question I raise three objections. First, I do not believe in the subjugating of the Engineer by the Town Clerk; I believe in co-operation on an equal footing, and nothing less. Secondly, I do not believe in over-estimating by 20 per cent. more than you require. You should be able to estimate within 10 per cent. The third objection I have is installing lights in houses where they are not wanted.

Councillor Spilkin: The greatest difficulty I have found in my experience is making the balance of the Council realise a position after discussing it with the Engineer. It is all right in a place like Durban where you have party politics interfering with the Council but in smaller places I have found that the best way to push through a proposition is to wait for a very long agenda, and put the Electricity items at the end. (Laughter.)

Mr. Foden (East London): I congratulate Mr. Sparks on his paper. I should just like to say what we do at East London. There we have frequent conferences with heads of departments, when all subjects are discussed, and we also have free discussion in committee. I must say that at East London there is no necessity for lobbying, which I thought I would just like to mention in passing.

Councillor Capell (Durban): I cannot agree with Mr. Sparks in his conclusions. I feel that the Electrical Engineer is a person of importance in a Municipal service and I have been responsible in Durban in seeing that the Electrical Engineer is placed on that footing. The Treasurer has been a sprag in the progress of the Electricity Department.

The extension of the hire purchase system in regard to appliances has had the sympathy of all Engineers but the conditions imposed by the Treasurer have made the position so difficult that these facilities have not really been made available to the public. If it were left to the Engineer, and the red tape imposed by the Treasurer done away with, the Electricity supply would develop far more rapidly. In regard to what Mr. Milton stated tariffs are most definitely not based upon cost, but upon the ability of the consumer to pay. Those who can pay should pay, and those who cannot pay should be given the benefit of a minimum rate.

Councillor Ball (Veregeening): I am impressed by the fact that this paper has come from one of the smaller municipalities. It has proved most acceptable to the Convention, particularly in view of the fact that the lead in these matters generally comes from the larger towns. As Councillors we feel that consultation between the Town Clerk, the Town Treasurer and the Electrical Engineer is essential to smooth working. Many Councillors are unable to get a real grasp of the actual working of an Electric Undertaking, and many do not take the trouble to ascertain how it is conducted. We should take full notice of the point raised by Councillor James, of Capetown. Personally, at all times I have experienced little difficulty in getting support from the Council for our Electrical Undertakings. The Engineer, as a rule, is not far out in his estimates of cost, etc., and he is the man by whom the Council must be guided. If we go back and work with our officials on the lines of co-operation tnd harmony we shall achieve our purpose. (Applause.)

REPLY.

Mr. Sparks: I will reply very briefly. Mr. Delport said that very often engineers do not know what they want. We know what we want all right, and that is to be able to supply cheap electricity.

With regard to Mr. Swingler's remarks about getting everything down in writing, this is very sound advice which I heartily endorse.

My remarks about estimating a certain scheme to cost £6,000 and then afterwards getting the Council to increase it to £8,000 have been misunderstood; this was not a case of under-estimating a job, but in the preparation of the original estimate of £6,000 it was decided to postpone certain work until 1941, when a large loan matured. The growth of Pietersburg, however, was such that it was imperative to carry out more work than was originally intended instead of waiting until 1941 to complete the whole scheme.

A good deal of discussion took place as to the status of the Electrical Engineer and conflicting opinions were expressed both by Councillors and Engineers. Some Councillors felt that the Engineer was usurping the position of the Councillors. I hold the following view, I believe whole-heartedly in co-operation; the Electrical Engineer can be looked upon as Manager of a Company and the Councillors Directors. I do not believe in divided control; someone must be directly responsible to the Council.

A certain amount has been said about interference from Town Treasurers, they have a knack of seeing things from a different point of view to the Engineer. Our Assistant Town Treasurer is second to none as far as the collection of arrears or outstandings are concerned; bad debts are practically non existent. Such a condition of affairs is sometimes to be gained at the restriction of business and I was compelled to ask him this question: "Which would you rather have, £100 worth of business and no bad debts or £1,000 worth of business and £100 worth of bad debts?" My Chairman, who is a business man, has told me that he knows certain of his customers will do him down eventually for £5 or so, but in the meantime he has done a £100 or so of business with them.

In reply to one or two points raised by Mr. Milton:—

Servicing of Stoves: Mr. Milton stated that the contractors might object to this work being done by the Municipality. We believe we can do this work better and cheaper than a contractor, which factor is vital to the success of Electrical Cooking. We compensate the Contractor, however, by putting work in his way which we think he can do better than we can; this enables him to keep and pay good men. I believe in this policy of co-operation and it is through this policy that Pietersburg is on the way to becoming an important engineering centre. The steel gates at the Iscor Pavilion, Johannesburg Exhibition, were made in Pietersburg.

Free Service Scheme for Stoves: The method in which the matter was put in my report was somewhat confusing, what I meant to infer was that the tariff could be so designed that provision could be made in the tariff for seservicing.

The President: I now call upon Mr. Mann to read his paper.

Further Notes on the

Guiding Policy

of the

Municipal Electricity Department

and its Results.

by F. C. D. Mann,
Municipal Electrical Engineer — Worcester.

In 1924 at Durban, I presented some 'Notes on the Guiding Policy of the Municipal Electrical Department' advocating a vigorous policy of service to the consumers, the word 'service' to be interpreted in the widest possible sense and not merely to be limited to keeping the mains alive.

Advertising, Education of the consumer—actual and potential; Provision of Hire facilities for appliances; and Low Tariffs, were suggested as among the essential parts of the electrical service and to the best of our ability these and other services have been made available to our community ever since and the results are now submitted for your information.

It was obvious that part of the service expected by any consumer would be prompt fuse replacements at any reasonable time of the day or night. Staff was therefore provided, at first till 10.30 p.m. and then from 6 a.m., so that on week days the staff are in direct telephonic reach from 6 a.m. till 10.30 p.m. On Sundays and Public Holidays two 3 hour periols, morning and evening, are sufficient.

Another service, much appreciated and vital to the ready development of the domestic loads, has been the provision of adequate stocks of spare parts, for all hired appliances and facilities have been provided to collect, repair and return users' appliances which require attention as soon as possible. Most calls are answered immediately, but delays sometimes occur with appliances purchased elsewhere, in such cases a loan of some similiar appliance is made to avoid inconvenience, pending the arrival of spare parts.

Some six years ago a Lady Demonstrator was added to the staff whose primary duties were to assist consumers with domestic electric problems, demonstrate appliances, and give monthly cookery demonstrations in the Office Building.

The Department has always been prepared to assist consumers in any way, with wiring, repairs, installation of motors, tanks, repair to motors, advice and estimates; a competent staff and resonably complete equipment has enabled us to meet most of the demands on our resources and to give satisfaction to our clients.

The local Cinema has been constantly used to display a varying succession of slides depicting some electrical idea, and for some years in addition, space in the local paper has been taken every week to spread the same ideas of Electricity for the home, works or farm .

Worcester is not an industrial centre; such industries as there are are mostly connected with fruit and fruit products, and tend to be seasonal; our chief opportunity for expansion lay in the domestic field and the charts show how this has responded. Additional plant or an alternative source of supply will be urgently needed within the next two years, as our proportion of stand by plant is already inadequate.

The diagrams attached to this paper show some of the results, probably generally similar to those achieved in many other small towns; they show steady growth of output with steadily falling tariffs and costs to consumer. Although we do not claim as yet to have been able to reach the low price levels of the big centres, we do claim to give an electricity supply within the reach of all who can normally make use of it at a reasonable price, with a reliability and attendant service and facilities at least equal to and in some ways better than the larger centres.

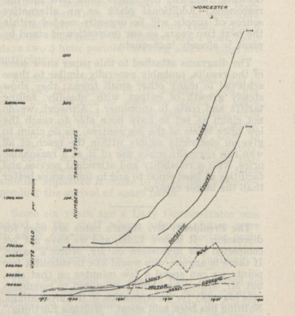
The President: Mr. Mann's notes are open for discussion. It is now 12.30, and we have not yet completed our discussion on Mr. Milton's paper. If there is anyone who would like to submit a few points we can spend a few minutes on that also, but Mr. Milton has kindly promised to communicate his reply for incorporation in the proceedings. Nothing has been said about "Multiple Earthing" as yet, for which possibly we shall be able to spare a little time to-morrow morning. Alternatively those who may have comments to make on that subject can forward them to the Secretary.

There being no further discussion the Convention adjourned at 12.35 p.m.

dition, space in the local paper has been taken every week to spread the same ideas of Electricity for the home, works or farm.

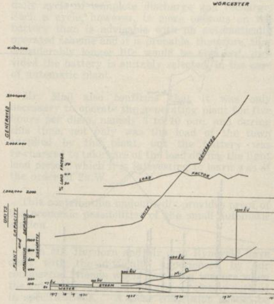
Worcester is not an industrial centre; such industries as there are are mostly connected with fruit and fruit products, and tend to be seasonal; our chief opportunity for expansion lay in the domestic field and the charts show how this has responded. Additional plant or an alternative source of supply will be urgently needed within the next two years, as our [illegible] plant is already inadequate.

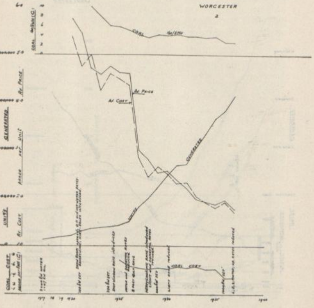
The diagrams attached to this paper show some of the results, probably generally similar to those achieved in many other small towns; they show steady growth of output with steadily falling tariffs and costs to consumer. Although we do not claim as yet to have been able to touch the low price levels of the big centres, we do claim to give an electricity supply within the reach of all who can normally make use of it at a reasonable price, and a reliability and attended service and facilities at least equal to and in some ways better than the larger centres.



The President: Mr. Mathers' notes are open for discussion. It is now 12.30, and we have still to complete our programme of visit, [illegible] If there is anyone who would like to submit points they can take a few minutes on that [illegible] Nothing has been said about as yet, for which possibly we shall be able to spare a little time to-morrow morning. Alternatively those who may have comments to make on that subject can forward them to the Secretary.

There being no further discussion, the Convention adjourned at 12.35 p.m.


WORCESTER
GENERATED
2,000,000
% LOAD FACTOR
LOAD
FACTOR
GENERATED
1,000,000
UNITS
PLANT CAPACITY and MAXIMUM DEMAND KILOWATTS
UNITS
M. D
STEAM
WATER


WORCESTER
2
COAL
AV. PRICE
AV. COST
GENERATED
UNITS
COAL COST

REPLY TO DISCUSSION ON "AUTOMATIC PLANTS FOR SMALL MUNICIPAL SCHEMES."

Mr. Milton (Communicated): Dealing with the discussions as they have been presented, I would reply as follows:—

Mr. Mail's experience of the use of batteries is of great interest as he is able to confirm that a battery will give seven years of useful life on a daily cycle of complete discharge and recharge. Such a cycle, however, is more onerous on the battery than is advisable with an automatically operated scheme and it is probable, therefore, that considerably longer life would be obtained, provided the battery is suitably selected, in the case of automatic plant.

Mr. Mail also confirms that it was only necessary to operate the generating plant for five hours per diem, namely 5 to 10 p.m. and during this time, not only was the load of the town supplied by the plant, but the battery was re-charged to take care of the load during the light load period, which it is interesting to learn was of the order of 2k.W.

This contribution undoubtedly provides proof of the economic possibilities of the small automatic station.

Both Mr. Heydorn and Mr. van Ryneveld have dealt with the difficulty experienced by our commercial friends when preparing tenders when the automatic requirements are not clearly defined in specifications. A clear conception should be arrived at as regards the essential features of the automatic equipment, and I hope my paper, elaborated by the discussion in this reply, will assist in this direction to some extent. Naturally individual cases must be treated on their merits, and it will probably be necessary to vary the automatic features to suit the particular case.

Mr. Heydorn makes the point that the decision to instal automatic plant arises entirely from financial considerations ,though it would possibly have been better had he said that the decision is based on the limited revenue available from small undertakings and the fact that for effective service the salaries and wages bill on a municipal undertaking has a minimum below which it is decidedly unwise to go, the minimum being relatively large in relation to the revenue. He then proceeds to deal with certain faults which cannot be taken care of by automatic equipment, such as the carbonising of cylinders and ports and the scaling of water jackets. As regards the relays also, expert attention is required from time to time to maintain this equipment in tune. In my opinion these considerations are not sufficient to warrant continuous supervision.

When putting forward the suggestions for automatic plant, I had in mind that the plant would be inspected by an expert from time to time, and that arrangements for this could be made when plant is purchased. In view of the short time of operation each evening, the period during which plant could be left safely in the hands of a semi-skilled man can be arrived at reasonably accurately, and it seems to me that an expert need only visit the plant say once every 12 months.

The chance of breakdown due to plant and equipment carbonising, scaling, or dirty relays is very remote, and in any case manufacturers of such plant should be in a position to recommend a regular programme of overhaul which would ensure satisfactory continuous service. In this connection the principal defect would be the failure of a set to start up and take the load when the peak load comes on, in which case the entire load would be imposed on the battery. As my recommendation is that the plant should be in charge of a part-time attendant, this defect would be noticeable within a very short time as the voltage drop would be excessive and would show up in dim street lighting and house lighting. Evidence of this nature would be so obvious that the part-time attendant would proceed to the power station. All automatic plants are provided with change-over switchgear to enable the plant to be started by hand and put into commission, and, if the reason for failure of the automats is not readily apparent to the part-time attendant, expert assistance could be invited by telegram or telephone. In the meanwhile, the generating plant could be run for a few hours each evening with part-time attendance.

The contract entered into between the part-time attendant and the Municipality should cover this point, and as occasions of this nature should be of rare occurrence, should not result in making the monthly payment very large. Special payments for such periods should, however, be avoided.

Mr. Sparks has offered the comment that, in his experience, generating plants installed are usually too small to meet the requirements of a town, because the town's finances and not the possible loading has been the deciding factor. He then mentions the possibility of a town with 60 consumers having 50 using refrigerators. It is most unlikely that any urban community in South Africa would provide such a ratio. Further, if the spending power of a community is such as to enable 50 out of the total of 60 consumers, to instal refrigerators, it is highly probable that ful-time attendance would be employed. I would go so far as to express the opinion that where 50 refrigerators, it is highly probable that full-time and total income would be far in excess of the maximum which would be permissible with automatic plant.

As regards the difficulty attending the supply of A.C. and D.C. at intervals, which Mr. Sparks has mentioned, I rather expected comment from a large number of members. There is no doubt that the use of alternate A.C. and D.C. does present serious difficulty where metering and household appliances are concerned. The use of automatic change-over switchgear in each house service for A.C./D.C. presents one possible solution to the metering difficulty, but does not appeal to me. On the other hand, the old type of wound meter which did not contain iron cores (the dynamometer type) would get over the difficulty, but I am not certain whether this type of meter is still available on the market at reasonable prices. The other difficulties in the way of the use of common domestic appliances, e.g., wireless sets, could only be overcome by instructions to consumers. Such instructions, however, might be disregarded, due to negligence, with serious consequences. In my view, unless the circumstances are abnormal, it is most unlikely that a satisfactory case could be made for the use of A.C. during the peak load period and D.C. for the light load period. My principal reason for putting forward the proposal was that I hoped to obtain overwhelming confirmation of my view as to the unsatisfactory nature of such a scheme from the members of the Association.

As Mr. van Ryneveld's discussion is lengthy, I propose to deal first with the two remaining discussions.

Mr. Bahr has urged that the plant should not be left in the care of the owner of a local garage. He also recommends that every care should be taken that the lubricating oil quantity should not be neglected and that automatic plants should not be too extensively employed.

Whilst there seems to be a widespread prejudice against garage mechanics when it comes to an engineering job, I feel confident that in the small towns of the Union a generating plant could safely be left in their care, my reason being that the isolation of the small towns usually demands of the garage owner and his mechanics more versatility and ability than in the larger towns.

The attendance on automatic plant should not call for any major overhaul or repair except under the advice and/or supervision of an expert. The object of providing attendance is to ensure that the general behaviour of the plant is observed by someone able to form a reliable opinion as to whether or not things are going well. In the event of the opinion being formed, by someone able to do so, that the plant is not operating satisfactorily, it should be restored to a satisfactory condition by someone fully capable of doing so, i.e., by someone provided by the suppliers of such plant.

As regards the neglect of lubricating oil, I feel sure that no more danger is likely to arise from this source if the plant is supervised by the local garage, than there is when the plant is supervised by underpaid permanent staff.

As regards going too far, with automatic plant, the intention of my paper was to bring before a number of small towns the possibility of availing themselves of the benefits attendant on electricity supply when those same towns could **not** afford to pay for full-time attendance. If any town can afford to pay for attendance, then I would strongly recommend that attendance be employed, and would go so far as to say that it is probable that the Chief Inspector of Factories would insist on staff being employed by the Municipality concerned. From this point of view, therefore, I feel that Mr. Bahr need not be too greatly concerned. On the other hand, I am satisfied there is a large number of small towns in the Union which could instal automatic plant, such as I have described in my paper, with general benefit to the community of the country. I will deal further with this aspect when replying to Mr. van Ryneveld's discussion.

Mr. Opperman seems to be strongly prejudiced against the D.C. system of supply and asks how many thousands of pounds this system has cost communities of the Union. The cost of change-over from the D.C. to the A.C. system of supply has involved many thousands of pounds expenditure, but this admission does not prove, or even indicate, that the Municipalities concerned were not wise in their first choice of D.C. to establish their undertakings.

If undertakings can be completely staffed then it will probably be found as a general rule that the annual cost of operation on either system of supply would be much the same, though for a small scheme it will probably be found that the D.C. system will show a small saving on the A.C. system. If the town concerned can, as a community, only afford the use of electricity for purely lighting purposes with no prospect of supplying industrial loads or the like for several years after the inception of electricity supply, then (where generation is involved) there is no doubt that a D.C. system with a battery and a staff comprising one engineer and an assistant will show to great advantage over the A.C. system in view of the fact that with the latter a 24-hour service could not be inaugurated. Comparing continuous and restricted hour services, the continuous service will result in far more rapid development of a community and its electrical needs to the stage where its electricity undertaking becomes a relatively large concern. I am of the opinion that, as electricity is a wonderful self-advertising medium, those small towns which have initiated their schemes on the D.C. system, rather than defer the inauguration of a scheme pending general development of the community, have produced electricity undertakings on a sound financial basis far earlier than had it been necessary for them to wait until they could inaugurate their schemes on the A.C. system of supply.

Much of the money which has been spent in the Union on the change-over from the direct to the alternating current system of supply, added to the cost of redundant plant, can be regarded as profitable advertisement, having made possible paying electricity undertakings able to finance these costs. Surely this is to the advantage of South Africa?

There are some cases, however, where the D.C. system of supply was adopted because at the time D.C. was considered to be the only system practicable for general distribution, and lighting formed almost the only direction of use. Many of these towns have continued with the D.C. system for long periods. The decision to change over from D.C. to A.C. in the case of the towns I have in mind cannot be compared with the problem of deciding when a small town, starting out to-day with a low tension overhead system, should change over. Admittedly a certain amount of waste has occurred, but even so, I would venture the opinion that if it were possible to make a reasonable analysis of the financial position, the towns which commenced on the D.C. system from an economic choice have ultimately arrived in a better financial position than would have been the case had A.C. been adopted at the outset. No positive proof of this can ever be submitted, however, as any estimate prepared would probably be attacked on the grounds of protagonism for one or other system of supply.

It has been suggested that automatic A.C. schemes could easily take the place of automatic D.C. schemes. Tenders for the two alternatives have been invited but no firm put forward an offer of a completely automatic A.C. plant! It is possible that the tenderers realised the futility of offering complete automatic A.C. equipment in view of its high cost of purchase and operation.

As regards the criticism that the cost of labour is as cheap as the cost of automatic equipment, having in mind that the latter may have to be abandoned, my own view is that much of the trouble experienced with small generating stations arises from the fact that cheap or underpaid labour is employed. If prime movers are to be maintained and serviced by inexpert operatives, we can only expect high maintenance costs and short life. If this aspect is considered in conjunction with the salaries and wages bill when making a comparison with the cost of the automatic equipment, the balance will be found to be in favour of the so-called expensive automatic devices, provided, of course, the use of such equipment is permissible.

A plea has been made for the adoption of standards from the merchants' point of view. Thinking engineers will admit the advisability of standardisation, and this has been achieved as far as the voltage of supply is concerned, the Electricity Control Board having laid down standards of supply voltage for both D.C. and A.C. systems of supply and frequency for A.C. This standardisation has been carried further by several authorities in the direction of house-wiring etc.

It may be implied that I have given greater consideration to the theoretical aspects of the problem than the practical aspects. Unfortunately it is not possible at the present time to bring forward comparative figures for the actual performance of the types of plant I have mentioned in my paper, though it should be possible to do so in a few years' time. In the absence of concrete examples, it has been necessary to apply practice, which I suggest is something different from a purely theoretical study of the problem. This, however, will be dealt with at greater length in my reply to Mr. van Ryneveld.

Mr. van Ryneveld has mentioned the first two impressions which he obtained on reading my paper, which were, firstly, that the plant might be too automatic and, therefore, too costly, and, secondly, that the importance of close voltage regulation and continuity of supply has been over-emphasised. He also deduces from three statements in my paper that a permanent employee of the Municipality is essential, and, therefore, that the automatic features of the plant would only be required to undertake the duties normally fulfilled by shiftmen.

If a full-time employee is available, it must be admitted that modifications to the automatic features mentioned in my paper are advisable. I have not mentioned any of these modifications in view of the fact that my paper was intended to deal entirely with fully automatic plants, supervised occasionally by a contract employee of the Municipality concerned. It would not be possible to obtain the services of "the local garage man" on a full-time basis, as obviously the major source of income of such an individual would be from his garage.

I wish to emphasise that for the contract to be successful, the automatic plant would require to be reliable and only demand attention from a part-time employee at extended intervals and at times which, in the majority of cases, would suit his convenience. If a part-time employee of this description is to spend the hours from 5 p.m. to, say, 10 or 11 p.m., daily, in attendance on the running plant, the Municipality would be better advised to take on a full-time employee, as it is unlikely that the plant would receive the attention of the most skilful garage hand or owner at such times.

I do not agree with the opinion that there is no object in providing automatic starting equipment for A.C. plant unless automatic paralleling is also provided. If automatic paralleling equipment cannot be economically included, it becomes necessary to provide individual generators, each capable of carrying the peak load of the station. As an alternative, however, a load detector relay could be used to change over the load from a small set to a large set at peak load period and revert to a small set when the load falls sufficiently, the change-over to take place during a "black-out" once the incoming set is up to speed and voltage, i.e., ready to go on the bars. Suitable interlocks woud have to be provided to ensure that no two sets could be switched on to the bars at the same time.

Mr. van Ryneveld has suggested that an attendant should run up and parallel two sets, in view of the fact that the time at which this is necessary can be predicted with reasonable accuracy. I would point out, however, that it is no simple matter to arrange for a part-time attendant to be at the power station at the appropriate times for starting up and shutting down. With a full-time attendant this is, of course, possible, and it is then not necessary to provide for either starting up or paralleling equipment, but where an attendant is available on full-time, the scheme does not fall within the scope of my paper.

The cost of automatic starting equipment is not very great and its omission would not allow for any material increase in the size of generating plant. Similarly, the cost of this equipment does not in any way approach the cost of permanent attendance.

I was pleased to note that Mr. van Ryneveld agreed with me that if two or three 5k.W. sets are sufficient for any particular village, that village must be satisfied with D.C., and automatic plant with a battery should be installed.

Mr. van Ryneveld's remarks on protection against bearing seizure bear out my own views on this subject, though I do feel a thermostat on the main bearings, which can be simply and cheaply fitted, does serve some useful purpose. It is not a rare occurrence to find, on periodic examination of main bearings of oil engine equipment, that at some time one or other of these bearings has been excessively hot without this fact having reached the notice of the power station staff. Similar faults with big and small end bearings are not of such frequent occurrence when plant has been put into service in good condition. I would venture the opinion that this is possibly due to the fact that misalignment of the main shafts which gives rise to bearing trouble occurs more frequently than the causes contributing to the failure of small and large end bearings.

Mr. van Ryneveld has commented on the difficulties to be faced in connection with the termination of charge and discharge cycles to suit main batteries and their end cells.

Whilst I admit a reasonably priced voltage relay for controlling the charging of cells may not have an excellent accuracy co-efficient, I feel that Mr. van Ryneveld has over-emphasised the necessity for extreme accuracy.

The generators used in conjunction with fully automatic plants should have suitable characteristics, which affects the probable reliability of the controlling relays. If no "end cells" are to be used, then it might be possible to use constant current generators. I am of the opinion, however, that the variation in voltage which would arise from battery charging in such a case would be beyond the reasonable limits which may be imposed on a distribution network. This difficulty might be overcome, say, by incorporating an automatic voltage regulator to control the voltage imposed on the network. This system would introduce further losses.

If a constant current generator is used on plant incorporating automatic end cell switchgear for distribution volage control, the end cells in such cases would most probably be seriously overcharged before charge on the entire battery could be completed. In this respect, therefore, Mr. van Ryneveld's assumption that I do not favour the use of automatic end cell switching devices is not correct. Automatically controlled end cell switching devices for both charging and discharging. are a little more expensive than hand-controlled cell switchgear and can be designed to control effectively the proper charging of the cells.

In my opinion end cell switchgear is essential if satisfactory voltage is to be maintained during the normal charging process. If a battery has been selected in accordance with the general opinions expressed in my paper it will generally be found in practice that no serious voltage drop will occur (during discharge) until the evening peak commences to be imposed. At this time the voltage will drop rapidly, due to heavy loading on a partly discharged battery, particularly as a properly selected battery would not have a total ampere hour capacity as great as the ampere hour output required daily by a small undertaking.

If the automatic plant operates reasonably satisfactorily it should be found that the total discharge from the battery will not exceed, say, 60 per cent. of its total capacity, that is, the battery would be capable of assisting the generating plant during peak load discharge when exceptional peaks are imposed, these exceptional peaks being usually of very short duration.

A satisfactory battery cycle does not require that the battery should receive a "full" (or equalising) charge each time charging takes place. With the lead acid type of cell the voltage rises very rapidly during the last quarter of the time required for effective charge: for example, a battery which would be completely charged in eight hours with a final voltage of the order of 2.75 volts per cell, would only require a voltage of 2.4 volts per cell at seven hours; that is, during the last hour of charge the voltage rises from 2.4 to 2.75, viz., by more than 10 per cent. In practice it would probably be found reasonable to cease charge when the voltage reached 2.6 or 2.65 volts per cell and, therefore, an error of 1 per cent. would only introduce a negligible difference in the extent of charge.

If alkaline cells are used, however, the difference in voltage between 80 per cent. of complete charge and complete charge would be approximately .1 of a volt where the final voltage would be of the order of, say, 1.8 volts per cell; that is, the difference would amount to about 5 per cent. In the case of this type of cell I am inclined to agree that the voltage relay alone may not prove entirely satisfactory in operation.

Mr. van Ryneveld has also pointed out that the voltage per cell during charge (and discharge) is dependent on the condition of the electrolyte, its level and temperature and also by the condition of the plates and joints on the inter-connections between cells. In the case of the lead acid cell the effect of temperature on the internal resistance of the cell is not very great as the temperature range arising from normal atmospheric conditions is not high in relation to the normal ultimate temperature of a cell in a battery room when the battery approaches the end of charge. In my opinion, under normal conditions of operation, the effect of temperature would produce a negligible difference in the final state of charge of a battery controlled by voltage relays. As regards the level, strength and condition of the electrolyte, it is reasonable to expect that the attendant could maintain this effectively between periods of expert attendance on the plant in so far as lead acid type cells are concerned. As far as alkaline cells are concerned, however, in view of the fact that the level of the electrolyte is not " visible " it is possible that neglect might result in serious changes in level, strength and condition sufficient to render the control of charge by voltage relays abortive.

As regards the condition of the plates, I am satisfied that automatic equipment, reasonably maintained, will result in healthier conditions than are usually experienced when a battery is subjected to special control on manual operation. I realise that my views in these respects will require to be proved in practice before they can be accepted without argument, and I am hopeful that proof will be forthcoming in this country within the next few years. I do not agree that it is necessary to check and adjust the settings of a voltage relay " constantly " if it is to fulfil its functions. If Mr. van Ryneveld had said " regularly," I would have agreed, but the interval of time between regular checks, with a satisfactory voltage relay, may amount to six or twelve months, unless positive indications of unsatisfactory operation have been observed by a semi-skilled attendant. In this connection, with lead acid cells, a semi-skilled attendant is quite capable of observing in good time that a voltage relay is not functioning effectively, and at all events in sufficient time to prevent permanent harm to the cells affected.

It may be that Mr. van Ryneveld has in mind that a voltage relay would operate on the voltage across the entire battery. Such a relay cannot be expected to ensure effective charging of all cells if end cell switchgear is used (whether automatic or hand operated). If automatic end cell switchgear is incorporated, the voltage relay must be so connected as to operate on the blocks of cells between end cell studs and must control each block in sequence before finally disconnecting the battery from the generator. The final action may be performed by operating the relay from a standard block of cells in the main battery, the block of cells in the main battery so used never acting as " end cells " for either charge or discharge purposes. That is, such a block would act as a " pilot " for the condition of all cells in the main battery.

Mr, van Ryneveld expresses the opinion that straight current controlled sets without voltage relays are more satisfactory for the installations I have in mind and mentions that this is also the opinion of the Development Laboratories of the General Electric Company, Limited.

In the case of lighting plants used for individual houses, it is probable that considerable argument could be brought forward in support of this suggestion, but in the case of Municipal schemes I am not satisfied that such plants would give satisfactory service. Whilst it is possible that the battery might be over-charged during prolonged light loads, this eventuality is most unlikely in Municipal schemes as a very substantial peak is experienced each evening throughout the year (when compared with the normal light load) and generating plant would come into service daily.

With a current controlled plant it is usual to find that the generator(s) shut down as soon as the load on the system falls somewhat below the setting at which the current relay brings a set into operation. While generators are running, the battery is likely to receive a charge (at a varying rate) but it is unlikely that the battery would receive an effective replacement to compensate for energy given out during the preceding discharge period. The battery would, therefore, be under-charged or over-charged each day. It is mentioned that over-charging the battery could be guarded against by an electrically controlled governor or suitable regulating resistance. The electrical governor would probably be such that the set would slow down to reduce the voltage across the generator terminals, or alternatively a regulating resistance would probably be designed to give the same effect. Both of these systems are in effect similar to voltage relays operated across the entire battery.

In the case of house lighting sets it is usual to find that relatively small loads will set the generator in motion and the battery, therefore, provides chiefly for starting up the set and, to some extent, for extremely small loads, such as a passage light, etc. In cases of this nature it is probable that current relays will provide satisfacory service as the battery can be reconditioned at frequent intervals by changing over to manual control and more particularly, because an instruction to the household not to use lights for a certain period can be enforced. The principal objection to sets of this type, where restoration of charge is to be provided for either daily or every two days, is that the voltage of a lead acid cell, for example, will—as mentioned in my paper—rise from 2 volts per cell to 2.65 volts per cell, the battery not being completely charged at this latter voltage. The total variation in voltage of each cell of the battery might be taken as 1.9 volts to 2.65 if the minimum voltage be taken as that experienced towards the end of the light load period. The percentage variation, based on the lower figure, would amount to approximately 39 per cent. and assuming the figure of 1.9 volts corresponds to a "minus 5 per cent." condition, the upper figure would correspond to a 32 per cent. rise, or alternatively, if the normal voltage is 230 volts at the power station the voltage imposed on the network might be over 300 volts towards the end of charge. I think it will be admitted that such a high voltage would cause serious damage to the equipment on any network of a Municipal scheme, the load on the network being small at the time.

I would draw attention to the fact that the maximum voltage I have mentioned is not sufficiently high to produce complete change of the charging rates that would exist in practice nor would it provide what is frequently termed an "equalising charge."

I would go so far as to say that equalising charges would very rarely be required with a battery restored to 2.65 volts per cell each evening with voltage relay control. The principal disadvantage, therefore, attaching to the use of current controlled sets lies in the voltage variation during charge. The voltage variation during discharge, occurring as it does when supplying very light loads, would probably be unnoticed and would not necessitate the use of end cell switch-gear.

As far as the alkaline type of cell is concerned, the position is quite as bad. The voltage variation in the case of this type of cell as mentioned in my paper may be expected to be from 1.22 to 1.86 volts per cell, that is a variation of approximately 50 per cent. on the basis of the lower voltage. If one assumes that the battery would only be supplying very light loads without the set in operation, the voltage of the alkaline cell might be assumed as 1.33 as a minimum, that is, the voltage variation would be .53 which on the basis of 1.33 volts per cell as a minimum, represents a total regulation of the order of 40 per cent. This characteristic is quite as bad as that of lead acid cells when used in conjunction with a current relay controlled plant.

Mr. van Ryneveld does not mention the voltage variation during the charging process, but mentions the possible objection to voltage variation during discharge which he disposes of as not being serious and I agree that he is correct, though I do not agree with the drop of 10 per cent. he has mentioned.

The suggestion to instal a small auxiliary booster of, say, one or two k.W. is one which might receive very serious consideration, but I would prefer that manufacturers of such plant should express their opinions of the suitability of such equipment. It seems to me that there would be some difficulties to overcome in connection with the automatic operation of such equipment, but these should not be insurmountable. On the other hand, however, the efficiency of such a booster might seriously detract from the economic value of a battery which is itself inherently inefficient.

I must thank Mr. van Ryneveld for his congratulations, but admit that I had not regarded myself as a "Pilgrim," though I am prepared to accept this designation if it turns out that I have been helpful in establishing "Paradise Regained" for any small towns in this country.

I wish to record my thanks to the Members of the Association and those visitors who added so much of value to my paper.

SATURDAY, 10th December, 1938.

The Convention resumed at 9.10 a.m. in the Ball Room of the Arthur's Seat Hotel, Sea Point, the President in the Chair.

The President: The business outstanding from the previous meeting includes the discussion on Mr. Kinsman's paper on "Earthing." As there has been no discussion on this subject, may I suggest that those who have anything to say will put it in writing for inclusion in the Convention Proceedings.

PAPERS FOR NEXT CONVENTION.

We have received promises of papers by Messrs. Mail (Kokstad), Seller (Boksburg), Foden (East London), Bevington (Kynsna), Milton (E.S.C.) and Le Mare (E.S.C.), and we will be very pleased to receive others.

CONCLUSION AND THANKS.

Mr. C. Clutterbuck (Pretoria): As I have to leave early this morning, I would like to say a few words. As you know, I am in charge of the administration of the Factories Act, and I would like to express my gratitude for the support given me in that connection. It is indeed pleasing to know that notwithstanding the largely extended area of Electricity supply during the past two years, the accident rate has declined considerably. (Applause.) But, while I congratulate you, I would also like to give you a warning and make a request. I refer to the amount of work done on live mains, and I would ask you to eliminate work on live mains as far as possible. In many cases the work to be done is left to a subordinate, and I would ask Engineers to take an interest in this matter. I thank you again for your support and for the opportunity of again attending your Convention. Unfortunately, I shall be retiring next month, so that this is probably the last Convention I shall have the privilege of attending. I again thank you all. (Applause.)

The President: There is a very pleasing duty that devolves upon me—to thank very heartily those visitors, particularly those from Capetown, for their assistance in carrying out the work of the Convention. When I notified a large number of people in Capetown interested in our work, of the fact of the Convention being held, I drew attention to the fact that its success would depend very largely upon the assistance given in regard to transport. They have come forward very nobly and we appreciate their help very much indeed. To those visitors as well as to those who have come by sea and otherwise, we express our thanks for their assistance and contributions to the discussions. It is interesting and important for us to know the views of those who see the other side of the picture. (Applause.)

Mr. Bottomley (Pretoria): I have to thank the Association very much for having invited me to attend this Convention, during which we have been presented with a series of very interesting papers. As a visitor I think the City Corporation of Capetown are to be congratulated upon the way in which they have entertained the Convention. It has been a case of service with a smile. Mr. Swingler has told us that he is regarded as a super salesman; I think we might add to that and say he is a super showman. (Applause and laughter.) One thing that has given me great satisfaction is that the Association has conferred the distinction of Honorary Membership upon our friend, Mr. Horrell. I have known him for 30 years, and am well aware of the good work he has done for the Association. It was a very nice gesture. I would also like to congratulate you, Mr. President, upon your election to the Presidential Chair, and from the way in which you have conducted the proceedings of the Convention we are certain that you will have a very successful year of office. (Applause.)

Councillor Spilkin: I just want to say that I have received a telegram from my Council expressing their great pleasure of the fact that the Convention is coming to Umtata next year. I can assure you that we will arrange an excellent programme. (Applause.)

Messrs. Bevington and Bahr, and Councillors Spilkins, Parry and Robbins also added their appreciation.

Councillor G. C. Starkey (East London): It is my privilege as a Councillor Delegate to express our appreciation of the generous hospitality that has been bestowed upon us by the Mayor and City Councillors of Capetown. That hospitality has been both enjoyable and instructive. We have seen the wonderful Power Station costing over £2,000,000, and we realise the enormous work the Mayor and Corporation, assisted by their staff, have put into that wonderful effort. Everything has gone on without a hitch, and while it may be good propaganda, it has certainly whetted our appetite to come back again and have more leisure at our disposal. We hope that the Mayor will convey to the City Corporation our most sincere thanks and appreciation of their generosity and kindness. Regarding the Mayor himself, I would like to say that he has brought his magnetic influence among us and we have learned to admire and appreciate his high qualities. We know the big demands upon his time, but he has come here again this morning, his hospitality has been most generous, and we will long remember all he has done for us. (Applause.)

Mr. Rodwell: On behalf of my brother engineers and myself, I also desire to express our hearty appreciation of the kindness of the Mayor and

Corporation of the City of Capetown for the wnderful facilities they have placed at our disposal. It has been apparent that neither time nor trouble has been spared to make our visit both profitable and enjoyable and there is no doubt that we will take back to our Cities and towns the happiest possible thoughts of what has been done for us. We know the work of that wonderful organiser, Ms. Swingler, from whom we expect nothing but the best. Once again, Mr. Mayor, we thank you for your hospitality, and can assure you that we will long remember the very pleasant week we have spent here in the Peninsula. (Applause.)

Mr. van Ryneveld (Capetown): I have been given the privilege of saying a few words on behalf of the visitors. It is indeed a privilege, for there are many distinguished visitors among us. I feel sure I am speaking for them all when I say how greatly we have appreciated the opportunity of attending this Convention and participating in the various discussions. It has been particularly noticeable, Mr. President, that at this Convention the visitors have been treated on a footing equal to that of the members of your Association. We have been included in all your invitations, and at no time have been allowed to feel that we were intruding. That has added materially to our enjoyment.

Special thanks are due to those who have taken such trouble concerning our social entertainment, and in this connection I would like to express our appreciation of what has been done by the Mayor and the City Corporation of Capetown, the Mayor and Council of Stellenbosch, not forgetting our good friend, Mr. Ritson. The arrangements made for our entertainment have been excellent. In this may I couple your name, Mr. President and also our friends of the Capetown Electricity Department. (Applause.)

Councillor James (Capetown): I would like to thank the distant members of the Convention for the part they have played in making this one of the happiest occasions I have experienced since I have been connected with the Association. We have not forgotten all you have done at this Convention. A Convention such as this does a considerable amount of good quite apart from the proceedings. I do not want you to think that we have done all this and that we are expecting nothing back. (Laughter.) It has been said that the people of Capetown are cold and reserved, but I think you have found that we have very warm hearts and that we have welcomed you gladly. I wish you all God-speed until we meet again next year at Umtata. (Applause.)

The Mayor of Capetown, Councillor Foster: It is a real pleasure for me to come here this morning, and to say a few words to the members of this Convention. I think I said when I opened your Convention on Monday that when I got back to the City Hall I would tell them that I had never seen a more intelligent body of men. (Laughter.) I know you have had a very successful Conference and that your job of work has been well done. I was very pleased indeed to hear the delegates from Rhodesia. I trust you will all have a very happy Christmas, and that you will all get back to your homes safe and well. (Applause.)

The President: Mr. Mayor, on behalf of the Association, we thank you very much for coming here this morning, and I take this opportunity of extending you the best wishes of the Association for a Merry Christmas and a Happy New Year. (Applause.)

Mr. Poole: There is one little omission, namely, to thank Mrs. Eastman, Mrs. Swingler and Mrs. Ritson for the trouble they have taken in extending hospitality to us. They have all done a great deal, and we are greatly indebted to them. (Applause.)

Mr. Swingler: While I much appreciate the many kind remarks that have been made, both my colleagues and myself will be only too happy at any time to be of service to the Association. If we have been able to make things pleasant for you all and you have benefited, then we are more than glad. We are not salesmen or showmen, but just men who are trying to do their job of work well. I thank you on behalf of the Electricity Department. We have been only too anxious to serve you. (Applause.)

Mr. Milton: I would have asked Mr. Swingler to speak on behalf of the Electricity Supply Commission, but being the senior officer of both the large concerns in Capetown, he could not very well do so. I, therefore, wish to express the thanks of the representatives of the Commission for the many kindnesses and courtesies you have extended. (Applause.)

Councillor G. L. E. Venter (Cradock): One thing that has struck me very forcibly has been the esprit de corps of the Convention. I hope this excellent spirit will obtain for many years. It is only by that means that we can do constructive work. I would also like to refer to the assistance we have received from the Supply Commission and the Association. As to the hospitality extended to us, I cannot add anything to what has already been so well expressed. (Applause.)

The President: In concluding the Convention, I would like to thank Mr. Councillor Venter for his reference to the esprit de corps that has characterised this Convention. Without that spirit the Convention could not have been a success and I personally appreciate it very much indeed. It has greatly helped us in carrying out our work in as smooth a manner as could be desired. Gentlemen, I thank you, and now declare the Convention closed.

The proceedings then terminated.

Association of Municipal Electricity Undertakings.

of South Africa and Rhodesia.

LIST OF VARIOUS MEMBERS,

as at December, 1938.

HONORARY MEMBERS.

H. J. van der BIJL, Electricity Supply Commission, Johannesburg.
L. L. HORRELL, Pretoria.
E. POOLE, Box 147, Durban. (Secretary and Treasurer).

COUNCILLOR MEMBERS.

Adelaide.
Alice.
Beaufort West.
Benoni.
Bloemfontein.
Boksburg.
Bulawayo.
Burgersdorp.
Cape Town.
Cradock.
Durban.
East London.
Ermelo.
Eshowe.
Fort Beaufort.
Fort Victoria.
Gatooma.
George.
Graaff-Reinet.
Grahamstown.
Gwelo.
Johannesburg.
Kimberley.
Klerksdorp.
Knysna.
Kokstad.
Krugersdorp.
Ladybrand.
Ladysmith.
Mafeking.
Matatiele.
Middleburg (Tvl.)
Nigel.
Pietersburg.
P.M.Burg.
Port Elizabeth.
Port Shepstone.
Port Alfred.
Piet Retief.
Paarl.
Pretoria.
Queenstown.
Roodepoort.
Randfontein.
Salisbury.
Springs.
Somerset East.
Springfontein.
Stellenbosch.
Uitenhage.
Umtata.
Upington.
Vereeniging.
Vryburg.
Walmer.
Worcester.

ENGINEER MEMBERS.

(* *Technical Assistants*)

ADAMS, B. N., Eshowe, Zululand.
ASHLEY, T. P. Queenstown, C.P.
H. BAHR, Klerksdorp, Transvaal.
BEHRENS, E. A., Port Elizabeth, C.P.
BEVINGTON, H. R., Knysna, C.P.
CLINTON, J. S., Salisbury, S. Rhodesia (*Member of Council*).
COPPIN, T. J., Walmer, C.P.
COULTHARD, R. D., Oudtshoorn, C.P.
DAVISON, J. G., Port Alfred, C.P.
DEKENAH, G., Ermelo, Transvaal.
*EASTMAN, H. A., Cape Town, C.P. (*President*).
ELLIOTT, A., Uitenhage, C.P.
EWER, G. G., Pietermaritzburg, Natal.
FITZSIMONS, T. S., Boksburg, Transvaal.
*FODEN, A., East London, C.P.
FOLEY, C. B., Vereeniging, Transvaal.
GRANDIN, P. C., Vryburg, C.P.
GREGOR, C. E., Standerton, Transvaal.
GROOM, H. L., Roodepoort, Transvaal.
GYLES, J. H., Durban (*Past President*).
HARVEY, A. Q., Springs, Transvaal (*Member of Council*).
HEASMAN, G. G., Fort Victoria, S. Rhodesia.
HOOPER, J., Robertson, C.P.
HOURELD, W., Randfontein, Transvaal.
HUGO, D. J., Pretoria, Transvaal (*Member of Council*).
IVERACH, J., Grahamstown, C.P.
JONES, G. E. H., Mafeking, C.P.
*KINSMAN, C., Durban, Natal.
KRUGER, J. J., Adelaide, C.P.
LAMBE, J. M., East London, C.P.
LEWIS, S. V. R., Gwelo, S. Rhodesia.
MAIL, W. M., Kokstad, East Griqualand.
MANN, F. C. D., Worcester, C.P.

MOCKE, T. M., Piet Retief, Transvaal.
MORRIS, H. A., Kimberley, C.P.
MULLER, H. M. S., Uppington, C.P.
MULLER, P. G., Krugersdorp, Transvaal.
NEWCOMBE, P. H., George, C.P.
NOAKES, C. F. L., Carolina, Transvaal.
NICHOLAS, I. J., Umtata, Transkei (*Vice President*).
PHILLIPS, J. W., Bulawayo, S. Rhodesia.
PIRIE, G. M. Bloemfontein, O.F.S. (*Member of Council*)
PREVOST, H. A., Somerset East, C.P.
RELIHAN, H. J., Paarl, C.P.
RODWELL, A. T., Johannesburg (*Past President*).
ROGERS, J., Fort Beaufort, C.P.
ROSS, W. D., Potchefstroom, Transvaal.
ROSSLER, A., Cradock, C.P.
ROSSLER, W., Ladybrand, O.F.S.
RITSON, D. W., Stellenbosch, C.P.
RUNTZLER, C., Port Shepstone, Natal.
SIBSON, A. R., Bulawayo, S. Rhodesia.
SPARKS, L. B., Pietersburg, Transvaal.
SMITH, M. M., Matatiele, E.G.
STEVENS, F., Ladysmith, Natal.
SMITH, E. L., Burgersdorp, C.P.
SWINGLER, G. H., Cape Town, C.P.
*TUBB, B. H. J., Salisbury, S. Rhodesia.
*WILSON, J. Pretoria, Transvaal.
WRIGHT, G. R. E., Benoni, Transvaal.
VERRYN, A. J., Middleburg, Transvaal.

ASSOCIATE MEMBER :

SELLER, W. J., Boksburg, Transvaal.

ASSOCIATES.

BASKERVILLE, C. H., Salisbury, S. Rhodesia.
BROWN, G. C., Colenso, Natal.
CASTLE, F., Cape Town, C.P.
CAMPBELL, A. R., Johannesburg, Transvaal.
DAWSON, C., Durban, Natal.
DELPORT, J. C., Kopjes, O.F.S.
DOBSON, J. H., Johannesburg, Transvaal.
MACAULAY, R., Pretoria, Transvaal
MARCHAND, B., Witbank, Transvaal.
PENTZ, J. O., Port Elizabeth, C.P
PRICE, E. T., Johannesburg, Transvaal.
PROCTOR, L. B., Johannesburg, Transvaal.
PURVES, H., Johannesburg, Transvaal.
STEWART, D. B., Umtali, S. Rhodesia.
STEWART, G. A., Johannesburg, Transvaal.
SYERS, F. E., Gatooma, S. Rhodesia.
WEST, J. A., Durban, Natal.

HAYNE & GIBSON (PTY), LTD.
"The Press at Kingsmead."
DURBAN.