PROCEEDINGS

of the

Fifteenth Convention

of the

Association of Municipal Electricity Undertakings.

of South Africa and Rhodesia.

(Founded 1915)

HELD AT

DURBAN

From Monday, November 8th to
Thursday, November, 11th

1937.

PRICE SEVEN SHILLINGS and SIX PENCE.

Index to Advertisements

J. H. GYLES, PRESIDENT
City Electrical Engineer,
DURBAN.

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INDEX

ASSOCIATION OF

Municipal Electricity Undertakings.

of South Africa and Rhodesia.

Founded 1915.

EXECUTIVE COUNCIL, 1937.

President :

J. H. GYLES (Durban).

Vice-President :

H. A. EASTMAN (Cape Town).

Past Presidents :

A. T. RODWELL (Johannesburg).
G. G. EWER (Pietermaritzburg).

Councillor Members :

H. G. CAPELL (Durban).
W. JAMES (Cape Town).
H. MIDDLEBROOK (Durban). *(Alternate).*
L. HOFMEYER (Stellenbosch). *(Alternate)*

Other Members :

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

Secretary and Treasurer :

E. POOLE,
P.O. Box 147 — Durban.

Association of Municipal Electricity Undertakings

of South Africa and Rhodesia.

MEMBERS AND DELEGATES AT DURBAN, 15th, CONVENTION, NOVEMBER 8th to 11th, 1937.

FIRST ROW—left to right—E. Poole (Durban) Sec. & Treas.; Clr. E. Spilkin (Umtata); Clr. E. W. Wright (George); J. S. Clinton (Salisbury); Mem. of Council; Clr. J. J. Coetzee (Springs); A. Q. Harvey (Springs) Mem. of Council; Clr. H. Capell (Durban) Mem. of Council; J. H. Gyles (Durban) President; Clr. Fleming Johnston (Durban) Mayor; A. Rodwell (Johannesburg) Past President; L. L. Horrell (Pretoria) Mem. of Council; G. M. Pirie (Bloemfontein) Mem. of Council; Clr. L. Hofmeyer (Stellenbosch) Mem. of Council (alternate); A. Foden (East London) visitor; Clr. H. Middlebrook (Durban) Mem. of Council (alternate); G. G. Ewer (Pietermaritzburg) Past President.

SECOND ROW—M. M. Smith (Matatiele); J. Iverach (Grahamstown); P. H. Newcombe (George); L. B. Sparks (Pietersburg); F. Stevens (Alice); J. W. Phillips (Bulawayo); Clr. R. L. Phillips (Salisbury); Clr. L. B. Fereday (Salisbury); D. W. Ritson (Stellenbosch); G. E. H. Jones (Mafeking); R. Macaulay (Bloemfontein); F. Castle (Capetown); W. H. Bottomley (Pretoria) visitor.

THIRD ROW——Clr. P. T. Louw (Springfontein); C. E. Gregor (Standerton); P. de K. van Heerden (Cradock) visitor; Clr. C. Butler (Cradock) Mayor; Clr. T. P. Gray (Johannesburg); Clr. C. F. Robbins (Pietermaritzburg); Clr. A. Sim (Queenstown); P. C. Grandin (Vryburg); O. A. Chrisp (Johannesburg) visitor; G. R. E. Wright (Benoni); Clr. C. T. Parker (Benoni); W. H. Milton (Electricity Supply Com.) visitor.

FOURTH ROW—Clr. A. Segall (Springfontein); Clr. A. L. Koller (Springfontein) Mayor; W. D. Ross (Potchefstroom); Clr. N. Gamsu (Nigel) Mayor; Clr. E .G. H. Barry (Robertson); J. Hooper (Robertson); Clr. G. R. Veel (Kokstad); F. Burgess (Durban) visitor; Clr. H. Quick (Ladysmith); C. Runtzler (Port Shepstone); Clr. C. Lennox (Port Shepstone); H. L. Groom (Roodepoort); G. J. Muller (Krugersdorp).

FIFTH ROW—H. A. Morris (Kimberley); H. Bickley (Nigel); T. P. Ashley (Queenstown); L. B. Proctor (Johannesburg); E. A. Behrens (Port Elizabeth); J. A. England (visitor); T. Jagger (Ladysmith); C. B. Foley (Vereeniging); E. R. Smith (Johannesburg) visitor; I. J. Nicholas (Umtata).

SIXTH ROW—A. E. Val Davies (Johannesburg) visitor; W. J. Seller (Boksburg); W. M. Mail (Kokstad); A. C. Collier (Durban) visitor; T. M. Mocke (Piet Retief); R. D. Coulthard (Oudtshoorn); R. W. Hayman (Johannesburg) visitor; H. J. S. Cremer (Johannesburg) visitor; Clr. M. N. Smith (Randfontein); G. R. D. Harding (Johannesburg) visitor; N. D. Penny (Colenso) visitor; S. G. Redman (Johannesburg) visitor; N. Reynolds (Johannesburg) visitor.

SEVENTH ROW—L. Hulbert (Johannesburg) visitor; J. H. Dobson (Johannesburg); Clr. G. Smit (Bloemfontein); F. N. Sutherland (Johannesburg) visitor; B. E. Mahon (Johannesburg) visitor; L. B. Marchand (Witbank); W. Houreld (Randfontein); G. Mortimer (Johannesburg) visitor; G. W. R. Le Mare (Johannesburg) visitor; R. Nothard (Johannesburg) visitor; J. Home Rigg (Johannesburg) visitor; H. A. Tinson (Johannesburg) visitor; C. B. Armstrong (Durban) visitor.

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.

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.

RULES AND CONSTITUTION.

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

1. TITLE.

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

2. OBJECTS.

The objects for which the Association is formed are :—

(a) To promote the interests of Municipal Electricity Undertakings.
(b) To bring Municipal Electrical Engineers and Chairmen and Members of Municipal Electricity Committees together.
(c) To arrange and hold periodically meetings for the reading of papers and discussions of subjects appertaining to Municipal Electricity Undertakings.
(d) To take such action as may be lawful and expedient for the protection and defence of the rights or interests of Municipal Electricity Undertakings.

3. MEMBERSHIP.

The Association shall consist of :—

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

All Hon. Members and Members of the Association of Municipal Electrical Engineers shall ipso facto become 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.

Fifteenth Convention

DURBAN.

Programme

Sunday, November 7th, 1937.

8.0 p.m.—Meeting of Council.

Monday, November 8th, 1937.

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

10.0 a.m.—Official opening of Convention by His Worship the Mayor of Durban (Councillor Fleming Johnston).

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

AGENDA.

1. Annual Report of Secretary & Treasurer.
2. Election of President.
3. Valedictory Address by Retiring President.
4. Presidential Address.
5. Place of meeting of next Convention.
6. Election of Officers.
7. Supply Regulations.
8. Licensing of Electricians.
9. General.

The following are the retiring Officers :—

President —A. Rodwell: Johannesburg.
Vice President —J. H. Gyles: Durban.
Past Presidents—G. G. Ewer: Pietermaritzburg.
L. L. Horrell : Pretoria.
Other Members—Cnclr. H. Middlebrook: Durban.
" T. P. Gray: Johannesburg
" F. Morrell: Capetown (alternate).
" J. McLean: Port Elizabeth (alternate)
Engr. G. H. Swingler: Capetown.
" T. Jagger: Ladysmith.
" E. A. Behrens: Port Elizabeth.
" G. M. Pirie: Bloemfontein

1.0 p.m.—Luncheon Adjournment.

3.0 p.m.—Opening of All-electric Exhibition (City Hall).

8.0 p.m.—Civic Reception and Dance, R.D.L.I. Hall, Epsom Road.

Tuesday, November 9th, 1937.

8.30 a.m.—Council Meeting.

9.15 a.m.—Official Photograph in front of City Hall main entrance, Gardiner Street.

10.0 a.m.—Paper by Councillor W. James (Capetown) "A Review of the Policy of Rate Relief from Municipal Electricity Undertaking Funds."

1.0 p.m.—Luncheon Adjournment.

2.30 p.m.—Trip round the Inner Harbour, (weather and other circumstances permitting).
(by kind permission of S.A.R. & H.)

and/or

Visit to the Congella Power Station.
(by kind invitation of the Electricity Supply Commission).

8.0 p.m.—"Good Night Vienna"—Pavilion, Marine Parade.
(Members and Council Delegates—Guests of City Council).

Wednesday, November 10th, 1937.

9.0 a.m.—Council Meeting.

10.0 a.m.—Paper by Mr. N. D. Penny (Colenso) "Progress and Development of the Natal Central Undertaking of the Electricity Supply Commission."

1.0 p.m.—Luncheon Adjournment.

2.0 p.m.—Visit to Mount Edgecombe Sugar Mill.
(by kind invitation of the Natal Estates, Ltd.)

8.0 p.m.—Circular drive to Bluff.

Thursday, November 11th, 1937.

9.0 a.m.—Council Meeting.

10.0 a.m.—Paper by Mr. C. Kinsman (Durban) "Earthing in relation to L.T. Supplies."

11.0 a.m.—Armistice Pause.

11.30 a.m.—Paper by Mr. H. M. S. Muller (Upington) "Administration of the Smaller Undertakings."

NOTES :

(a) The Convention will close at 1 p.m. sharp, giving ample time to passengers who intend embarking on the outgoing mail boat on Thursday.

(b) As the various outings are subject to transport available, those attending the Convention with motor cars are asked to kindly advise the Secretary of any seats available as early as possible.

(c) Trolley Buses leaving Church St. every 5 minutes for Pavilion and Beach, and Trams leave G.P.O. every 5 minutes for Epsom Road.

LADIES PROGRAMME.

Monday, November 8th, 1937.

10.0 a.m.—Official Welcome—Marine Hotel Ball Room.

3.0 p.m.—Opening of All-electric Exhibition —City Hall.

8.0 p.m.—Civic Reception.

Tuesday, November 9th, 1937.

11.0 a.m.—Morning Tea (Hostess — the Mayoress). City Hall, West St. entrance. Top floor.

2.30 p.m.—Trip round the Inner Harbour.

8.0 p.m.—"Good Night Vienna"—Pavilion, Marine Parade.

Wednesday, November 10th, 1937.

10.30 a.m.—Visit to Lever Bros.' Soap Factory—Congella.

2.0 p.m.—Visit to Mount Edgecombe Sugar Mill.

8.0 p.m.—Circular Drive to Bluff.

Thursday, November 11th, 1937.

10.30 a.m.—Morning Tea and Drive.—(Hostess, the President's wife).

Association of

Municipal Electricity Undertakings.

of South Africa and Rhodesia.

MEMBERS AND OTHERS ATTENDING THE CONVENTION.

ENGINEERS AND COUNCILLORS :

ALICE—
F. Stevens.

BENONI—
G. R. E. Wright.
Councillor C. T. Parker.

BOKSBURG—
W. J. Seller.

BLOEMFONTEIN—
G. M. Pirie.
Councillor G. Smit.

BULAWAYO—
J. W. Phillips.

CAPE TOWN—
G. H. Swingler.
Councillor W. James.

CRADOCK—
A Rossler.
Councillor C. Butler (Mayor).
P. de K. van Heerden, (Town Clerk).

DURBAN—
J. H. Gyles.
C. Kinsman.
Councillor Fleming Johnston (Mayor).
,, H. G. Capell.
,, H. Middlebrook.

EAST LONDON—
A. Foden.

GEORGE—
P. H. Newcombe.
Councillor E. W. Wright.

GRAHAMSTOWN—
J. Iverach.

GREYTOWN—
J. R. Stayt.

HARRISMITH—
A. E. Howard.

JOHANNESBURG—
A. T. Rodwell.
Councillor T. P. Gray.

KIMBERLEY—
H. A. Morris.

KOKSTAD—
W. Mail.
Councillor Rev. G. R. Veel.
,, J. S. Barton.

KRUGERSDORP—
G. J. Muller.
Councillor A. J. Tinker (Mayor).

LADYSMITH—
T. Jagger.
Councillor H. Quick.

MAFEKING—
G. E. H. Jones.

MATATIELE—
M. M. Smith.

NIGEL—
H. Bickley.
Councillor N. Gamsu (Mayor).

OUDTSHOORN—
R. D. Coulthard.

PIETERSBURG—
L. B. Sparks.

PIET RETIEF—
T. M. Mocke.

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

PORT ELIZABETH—
E. A. Behrens.
Councillor J. W. Lea.

PORT SHEPSTONE—
C. Runtzler.
Councillor C. Lennox.

PRETORIA—
L. L. Horrell.
Councillor F. Hopf.

QUEENSTOWN—
T. P. Ashley.
Councillor A. Sim.

RANDFONTEIN—
W. Houreld.
Councillor M. N. Smith.

ROBERTSON—
J. Hooper.
Councillor E. G. H. Barry.

ROODEPOORT—
H. Groom.

SALISBURY—
J. S. Clinton.
Councillor L. B. Fereday
,, R. L. Philips.

STANDERTON—
C. E. Gregor.

SPRINGS—
A. Q. Harvey.
Councillor J. J. Coetzee.
,, C. B. Davies.

SPRINGFONTEIN—
Councillor A. L. Koller (Mayor).
,, A. Sampson.
,, P. T. Louw.

STELLENBOSCH—
D. W. Ritson.
Councillor L. Hofmeyer.

UMTATA—
I. J. Nicholas.
Councillor E. Spilkin.

UPINGTON—
H. M. S. Muller.

VEREENIGING—
C. B. Foley.

VRYBURG—
P. C. Grandin.

ASSOCIATE MEMBERS :

B. Marchand, Witbank; F. Castle, Capetown; L. B. Proctor, J. H. Dobson, Johannesburg; C. Dawson, J. A. West, Durban; R. Macaulay, Bloemfontein.

SUNDRY DELEGATES :

Electricity Supply Commission :	W. P. M. Henderson, Durban; E. L. Damant, Durban; W. H. Milton; G. W. R. Le Mare; Johannesburg; N. D. Penny, Colenso.
Union Government :—	
S.A. Railways & Harbours :	G. A. Dalton; H. English, Durban.
Labour & Social Welfare :	H. O. Smith; W. Lindemann, Durban.
Public Works (Electrical) :	A. E. Glisson, Durban.
Chamber of Commerce :	W. B. Collier, Durban.
World Power Conference :	G. R. D. Harding, Johannesburg.
Natal University College :	Prof. H. Clark; Prof. J. H. Neal.
Kindred Institutions :—	
Institution of C.M. & E. E. :	A. C. Collier, Durban.
Natal Institute of Engineers :	G. W. Wilson, Durban.
Various :	F. Spray; J. K. Dixon, A. E. Val Davies; J. H. White; J. B. Godfrey; F. H. Wootten; F. Macbeth; P. Johnstone; J. R. H. Simpson.

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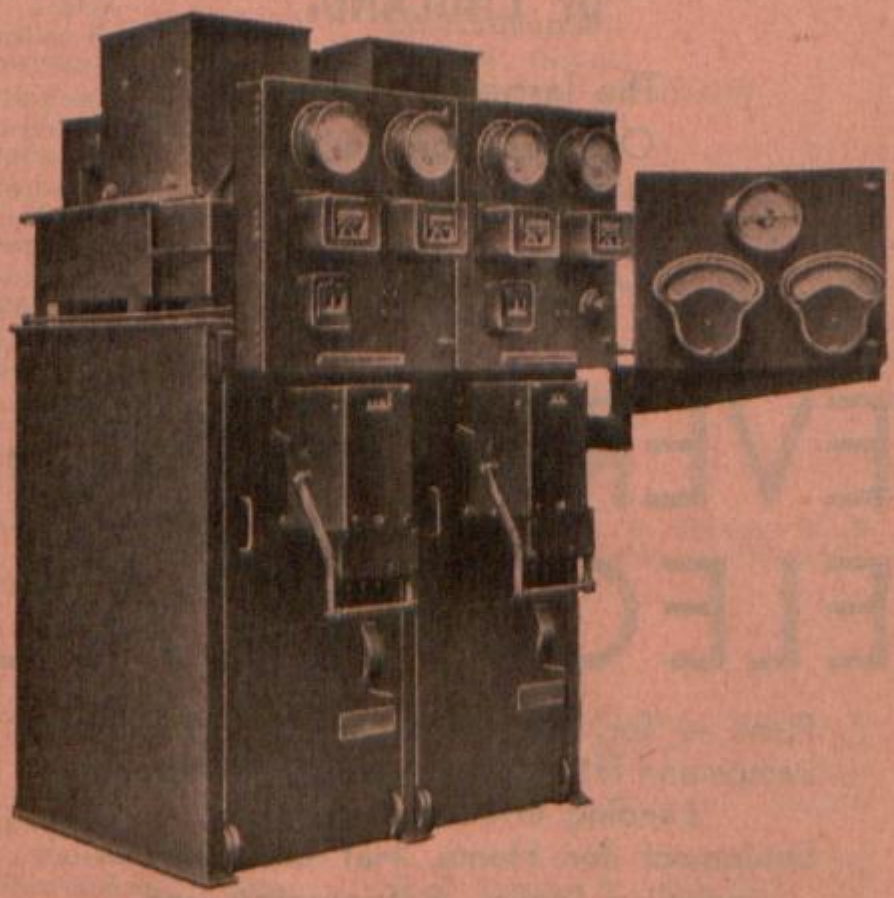
(S.A.) LTD.



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JOHANNESBURG.

ELECTRICAL TRADES :

Allenwest (S.A.) Ltd. :	J. H. Rigg.
Bartle & Co., Ltd. :	T. Bull.
British General Electric Co., Ltd. :	H. M. Witherspoon; F. C. Canning; J. McMurray; A. E. Robinson; J. P. Thomas; G. Mortimer.
B.I.W. Co., Ltd. :	F. Castle.
Boksburg Brick & Fire Clay Co. Ltd. :	
Chloride Battery Co., Ltd. :	A. C. Tilley.
Crompton Parkinson, Co., Ltd. :	A. B. Stratford.
Dowson & Dobson :	J. H. Dobson.
English Electric Co., Ltd. :	F. N. Sutherland; B. E. Mahon.
Fraser & Chalmers, Ltd. :	G. Dunn.
Hubert Davies & Co., Ltd. :	T. H. Harris.
	J. T. Pyott.
International Combustion S.A. (Pty.) Ltd. :	G. R. Nothord.
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Johnson & Phillips (S.A.) Ltd. :	J. A. England.
Metropolitan-Vickers Co., Ltd. :	J. W. Wyles.
Parsons & Co., Ltd. :	N. O. Curry.
Reunert & Lenz, Ltd. :	G. Drewett.
	L. B. Proctor.
Reyrolle & Co., Ltd. :	O. A. Chrisp.
Reynolds Sons & Partners, Ltd. :	N. Reynolds; P. Callie.
	H. A. Tinson; E. Hall; C. B. Armstrong.
S.A. General Electric Co., Ltd.	
S.A.C.M.A. :	E. R. Smith.
Siemens S.A., Ltd. :	H. J. S. Cremer.
Stewarts & Lloyds, S. A. Ltd. :	H. G. Reid.
Simplex Electric Co. Ltd. (S.A.) :	C. L. Hulbert.
Waygood-Otis :	R. H. Buchanan.
Wilson & Herd :	R. W. Hayman.

LADIES :

Mesdames : Ashley; Behrens; Bottomley; Curry; Coulthard; Callie; Chrisp; Dunn; Davies; Dawson; Ewer; Foley; Gyles; Gamsu; Harris; Horrell; Harvey; Howard; Hayman; Johnstone; Kinsman; Lindemann; Mail; McMurray; Milton; Muller; Penny; Poole; Rossler; Rodwell; Reynolds; Runtzler; Stevens; Seller; Sim; Sparks; Tilley; Veel; White; Woods; Wright and the Misses Gyles, Redman, Robbins and Poole.

OFFICIALS :

A. Mitchell, Reporter (Durban); W. W. Pittaway; J. W. Easterbrook; W. Caithness; E. Poole, Secretary & Treasurer (Durban).

PROCEEDINGS
OF THE
Fifteenth Convention

MONDAY, 8th November, 1937.

INTRODUCTORY.

THE Fifteenth Convention of the Association of Municipal Electricity Undertakings (Union of South Africa and Rhodesia) was opened in the Ball Room, Marine Hotel, Durban, at 10 a.m. on Monday, November 8th, 1937, and was attended by representatives from 41 Municipalities including 31 Councillor Members, 35 Engineer Members, 7 Associates, 24 Engineer Visitors, 34 Trades representatives, 5 Sundry Visitors and 43 Ladies.

The President, Mr. A. T. Rodwell (Johannesburg) in the Chair : Ladies and Gentlemen, it affords me a great deal of pleasure to introduce to you His Worship the Mayor of Durban, Councillor Fleming Johnston, who has kindly consented to open our Convention. (Applause).

CIVIC WELCOME.

His Worship the Mayor of Durban (Clr. Fleming Johnston): Mr. President, Ladies and Gentlemen; it gives me very great pleasure to be here this morning to open this Convention.

From an experience I had two or three years ago, I think it was in Salisbury, when I was Chairman of the Electricity Committee of the City of Durban, I know just how you feel in regard to the business you have before you. I also know the importance of your business and the benefit that

must result to the various Undertakings you represent. I have to make this admission — that while I managed to see the proof of your agenda, I could not find time to read all the papers, because up to ten minutes ago the clerk had forgotten to put down that I was to attend this meeting. As I have said, I did not find time to read all there is, but I noticed that in one of the items you want to find out how you can supply electricity for nothing. (Laughter).

There is at least one important item on your agenda, namely the question of Contributions from Electrical Undertakings for the Relief of Rates. As the writer states at the beginning of his paper, this is a very controversial subject, concerning which we all have different views, but whatever those views may be, you must always bear in mind that municipalities that trade do not always make a profit. You have to bear in mind when you are discussing this matter that it does not always follow that there will be a profit; there may possibly be a loss.

I have in mind what happened in Durban two or three years ago, when there were certain losses that had to be provided for. If you have to make up losses with the right hand I think you will be able to show that you are entitled to take a small contribution for the relief of rates with the left hand. If I have the time I hope to have the privilege of listening to this discussion. In any event, I shall be very disappointed if the Chairman of our Electricity Committee does not hear that discussion, because I think it will be an education for him, this being the first time he has sat in a Conference of this kind.

There is only one thing I would like to say, and that is that we have in Durban all the necessary facilities for Conferences of this kind, and that we can give you a full measure of interest and enjoyment. This is undoubtedly one of the most important Conferences that thas ever come to

Durban, because it represents all the Electrical Undertakings in the country, and on behalf of this City I extend to you all a most cordial welcome, coupled with the hope that you will fully enjoy your stay amongst us. I now have much pleasure in declaring this Convention open. (App).

The President (Mr. A. T. Rodwell): Mr. Mayor, on behalf of the Association of Municipal Electricity Undertakings of South Africa and Rhodesia, I wish to thank you and the City Council for the hearty manner in which we have been welcomed here.

From the programme it is apparent that neither time nor trouble have been spared to make the period profitable and enjoyable, not only for members, but for the ladies also. We are all grateful for the facilities for discussion, cultural advancement and entertainment placed at our disposal in this progressive City, which is situated in such beautiful surroundings, and we thank you heartily, Mr. Mayor, for the valuable time you have spared to us in connection with this Convention. (App.)

APOLOGIES.

The only apologies for non-attendance are from Mr. Meterlekamp of the Rhodesia Electricity Supply Commission, Mr. Adcock, Mayor of Port Elizabeth, and our old friend Mr. Clutterbuck, Chief Inspector of Factories. These indicate that most of our members are present. (Applause).

CONFIRMATION OF MINUTES.

The minutes of the various meetings held last year have been circulated, and I will ask you to take them as read, and confirm them.

Agreed.

ANNUAL REPORT AND BALANCE SHEET.

The President : I will now ask the Secretary and Treasurer to present his Annual Report.

FIFTEENTH REPORT and BALANCE SHEET of the Association of Municipal Electricity Undertakings for the period ending August 31st, 1937.

Mr. President and Gentlemen,

I have the honour to present herewith the Fifteenth Report and Balance Sheet covering the affairs of the Association since the 1936 Convention held at Johannesburg.

MEMBERSHIP.

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

	1936 :	1937 :
Honorary Members	3	2
Councillor Members	51	51
Engineer Members	63	63
Associate Members	4	2
Associates	16	19
	137	137

OBITUARY.

It is with much regret that I refer to the loss the Association has sustained by the death of Mr. John Roberts, one of the founders of this Association.

It was at the Port Elizabeth Convention in 1933 that the Association conferred on Mr. Roberts the distinction of Honorary Member as a mark of appreciation of his very keen interest in the affairs of the Association, and the many useful contributions he had made from time to time to our Proceedings.

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.

Draft measures prepared by the Government department concerned are now under the consideration of the various interested bodies, including our own Association, and there is every reason to hope that the matter will have the early consideration of Parliament.

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, though the result of our actual years working shows a deficit of close on £49. The Income for the year was practically the same as for the previous year, but the Expenditure increased by approximately £95, due partly to cost of Printing and Reporting of the Proceedings which was much larger than any of our previous issues, to which is added the Secretarial expenses in connection with which was the largest Convention yet held.

The arrears only amount to £8 5s. 0d. of which £6 6s. 0d. is in respect of Subscriptions for the period 1935/36 and which I recommend should be written off as irrecoverable and the names of those concerned should be removed from the register.

I would again direct members attention to one way in which our funds may be assisted, and that is by the purchase of extra copies of our pro-

ASSOCIATION OF MUNICIPAL ELECTRICITY UNDERTAKINGS
of South Africa and Rhodesia.

REVENUE AND EXPENDITURE ACCOUNT FOR THE YEAR
1st September, 1936 to 31st August, 1937.

Expenditure :

	£ s. d.	£ s. d.
Convention Expenses—		
Reporting	52 0 0	
Secretary's expenses	20 2 5	
Printing advance papers	4 17 6	
Programmes and Badges	15 4 0	
		92 3 11
Audit		3 3 0
Statistical Tables		10 0 0
Donation (World Power Conference)		10 0 0
Printing Proceedings		154 19 6
Sundry Printing, Stationery, &c.	34 5 6	
Less sales	18 2 6	
		16 3 0
Salary—Secretary		80 0 0
Secretarial expenses—		
I.M.E.A.	5 3 9	
Postages and Railage	20 0 2	
Telegrams and Phones	2 17 5	
Sundry	1 6 10	
		29 8 2
Bank charges	4 15 5	
Less recovered	8 6	
		4 6 11
Written off—		
Subscriptions, 1934/35		9 9 0
		£409 13 6

Revenue :

	£ s. d.	£ s. d.
Subscriptions		219 9 0
Proceedings		70 15 0
Advertisements		44 2 0
I.M.E.A.		5 14 0
Statistical Tables		21 0 0
Balance being excess Expenditure over Revenue		48 13 6
		£409 13 6

BALANCE SHEET AS AT 31st AUGUST, 1937.

Liabilities :	£ s. d.	£ s. d.
Subscriptions paid in advance		3 3 0
Accumulated Fund—		
Balance as at 31/8/36	346 11 8	
Less loss for year	48 13 6	
	297 18 2	
Add accrued Interest		
Union Loan	29 3 4	
		327 1 6
		£330 4 6

Assets :	£ s. d.	£ s. d.
Investment—		
Union Loan Certificate	200 0 0	
Accrued Interest	29 3 4	
		229 3 4
Sundry Debtors—		
Subscriptions for 1935/36	6 6 0	
do. 1936/37	1 1 0	
I.M.E.A. 1936/37	18 0	
		8 5 0
Cash at Bank		92 16 2
		£330 4 6

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.

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

30/9/37.

ceedings, so that at least each member of their Committee is in possession of a copy; it will be noticed that subscriptions alone only covers just half of our expenses.

I am
Mr. President and Gentlemen,
Yours faithfully,
E. POOLE,
Secretary and Treasurer.

30th September, 1937.

Mr. Horrell (Pretoria) : I have much pleasure in moving the adoption of the Report and Balance Sheet.

Mr. Marchand (Witbank) : I second.

Agreed.

CONDOLENCES.

The President : It is with deep sorrow that we have to record the death during the year of Mr. John Roberts, of this City, and Mr. Gunther, of Springfontein.

Mr. John Roberts was one of the pioneers of this Association, its second President and for many years a Council member. The distinction of Honorary Member was conferred on him to mark our appreciation of his outstanding services. Our late colleague's work in the Association and municipal electrical engineering in South Africa is an inspiration to us all, and is so well known that it needs no eulogy from me. His quiet manner and sound judgment had a great influence on our deliberations and discussions, and his work and influence in this City, in the Association, and South Africa as a whole is a monument to his memory.

I move that this Association places on record its deep regret at the loss sustained through the death of Mr. John Roberts, Past-President, and its deep appreciation of the valuable services rendered by him to the Association. I ask you to rise as a mark of respect to their memories.

ELECTION OF PRESIDENT.

The President : We have now to elect our President for the ensuing year, and it gives me much pleasure to move from the chair that Mr. J. H. Gyles, Vice-President, be elected President. (Applause).

Mr. Clinton (Salisbury) : I second that.

The President : There being no other nominations I have great pleasure in announcing Mr. J. H. Gyles, City Electrical Engineer of Durban, as President, and I will now ask him to assume that position with our sincere congratulations and the wish that he may have a very successful year of office. (Applause).

(Mr. Gyles then took the Presidential Chair).

The President (Mr. J. H. Gyles) : I thank you very much indeed for the great honour you have conferred upon me by electing me as your President for the coming year, and I shall refer to it further in the course of my Presidential address. I will now call upon Mr. Rodwell to deliver his Valedictory address.

Retiring President's Valedictory Address.

by A. Rodwell, M.I.E.E., M.I.Mech. E.,
Chief Engineer and General Manager, Electricity Department, Johannesburg.

Gentlemen,

When you honoured me by electing me President of your Association last year, I aspired to a progressive policy, to emulate those eminent in electrical engineering fields who have preceded me. If I have in any way failed to reach the standard set it is not for lack of endeavour but rather due to the extraordinary expansion of the Johannesburg City Council's electricity undertaking necessitating my absence overseas for a portion of the period of my Presidency, coupled with the enormous field of work now covered by our profession.

My term of office has been particularly pleasant. The year has been crowded with important events and developments, commencing with our "Coming of Age" Convention at the Empire Exhibition which coincided with Johannesburg's "Golden Jubilee" Celebrations.

There was a record attendance at the Convention, 51 towns being represented on the Association at that time, but there are a number of small towns which are not yet represented and this involves a definite loss to the ratepayers of those towns which are eligible. It is sincerely to be hoped that those who guide the destinies of such towns will, in a spirit of co-operation and with

an earnest desire for their advancement, insist that the amenities of the Association shall in future be available to their communities through representative members.

Dealing with "Supply Regulations," at the last Convention I announced that, taking as a basis the suggested by-laws prepared originally in Capetown, a Safety First Committee on which our Association was fully represented, sitting in Johannesburg together with representatives of all allied interests reached agreement on all points. The onerous duty of correlating all the various amendments was undertaken by Mr. E. T. Price of the Electricity Supply Commission and it was hoped that the completed work would have been in your hands some time ago, but the extraordinary developments taking place with the consequent rush of work devolving on the Electricity Supply Commission's officials prevented this; the regulations are, however, now ready for distribution and the subject will be elucidated by Mr. Milton of the Electricity Supply Commission.

A considerable amount of work has been done by past Councils of the Association to place the "Licensing of Electricians" on a sound basis. This matter is recognised as one the the utmost importance to ensure a reasonable standard of work and materials in installations and electrical equipment. Our efforts in this direction with the present arrangement do not achieve the standard desired. Without proper and adequate legislation there is no solid foundation on which to build. This was dealt with at some length at our last Convention and as a result unanimous resolutions from our Association in connection with this matter were forwarded to the Secretary for the Interior. In view of the sympathetic support of that Department and the Department of Labour, it was hoped that legislation would place the matter on a satisfactory basis during the year under review, and strong representations to attain this end were made by the City of Capetown and allied interests there.

As a result of the failure to enforce by-laws satisfactorily at Johannesburg, meetings were held there and representations were made to the Department of Labour by representatives of the following bodies :—

Johannesburg Board for the Licensing of Electricians;
South African Institute of Electrical Engineers;
Institution of Certificated Engineers;
Master Builders' & Allied Trades' Association;
Witwatersrand University;
Amalgamated Engineering Union;
South African Electrical Workers' Association; and
Building Workers' Industrial Union.

The Johannesburg Licensing Board was notified by the Secretary for Labour that it had now been agreed that the licensing of electricians should be controlled by that Department under the Factories Act by suitable regulations to be applied throughout the Union of South Africa. Steps were taken to prepare an amending Bill dealing with the licensing of electricians and contractors but owing to the time required it was not possible to introduce the necessary legislation during the last parliamentary session. Whilst the delay is regrettable, it appears almost certain that we may epect suitable legislation to be enacted during the forthcoming session of Parliament, thereby placing this matter on a sound foundation, to the benefit of the people of South Africa.

The expansion of the industry and increasing demand for electricity shows no sign of abatement. The increase for the year ending June 1937 over the previous year of the undertaking with which the writer is connected was :—

Unit output	.. ..	25.9 per cent increase ;
Maximum demand	..	27.9 per cent increase ;

and the rate of increase is accelerating. This, in common with other electricity undertakings, not only necessitates the provision of additional plant

and equipment but also introduces problems associated with large increases in fault rupturing capacity and inadequacy of existing plant to deal with the altered conditions. Whilst it may be possible to obtain an increase in capacity from existing switchgear by alteration of its mechanism. this can only be effected to a limited extent.

The growth towards larger sizes of equipment requiring new principles of design and constant new development brings about that bugbear of the engineer—the necessity of scrapping existing plant due to obsolescense long before it has served its useful "life" under the conditions which previously attained and on which the capital charges were based.

During my recent visit overseas, I was privileged to study these problems and the methods employed there to meet similar conditions. Unfortunately, great difficulty is experienced in keeping pace with the increasing demands at the present time; the armaments race has seriously affected delivery of plant and materials, and there is little indication at the present time that these difficulties will be minimised in the near future.

Associated with the problem of attempting to make provision for anticipated increases in demand is the question of estimating the cost thereof. When prices are reasonably firm and labour disputes non-existent, the costs may generally be estimated with a fair degree of accuracy but, due to increased costs of material and production in recent times, many estimates of even a few months ago have of necessity to be increased. The demands must, however be met and as far as possible there should be no diminution on this account of necessary additions and extensions to generation and distribution plant for electricity supply. Failure to make provision to meet demand will result in retarding progress, to the disadvantage of the communities served and with the possibility or public rebuke to those responsible for the furnishing of their requirements.

In spite of the difficulties the rate of advancement in electrical engineering has been phenomenal, and we should anticipate plant requirements rather than wait on events.

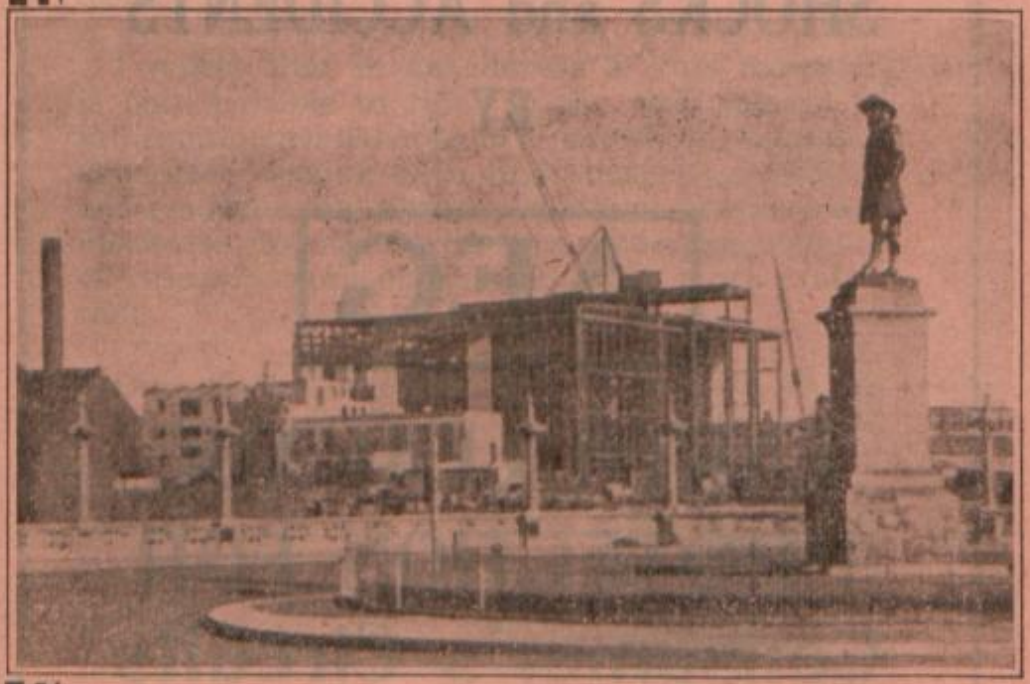
I was privileged to attend the International Conference of Electric High Tension Systems held in Paris during last June—July (1937) as the official delegate of the South African National Committee of the World Power Conference, when papers of exceptional merit dealing with the remarkable progress of our profession in this particular field of endeavour were read and discussed, and inspections were made of existing plant and equipment.

I regret that in an address of this nature it is only possible to refer to the vast amount of information available from a perusal of the papers submitted dealing with high tension generation and transmission, high speed circuit breakers and insulation together with a considerable amount of research work on lightning and surge protection.

One of the outstanding achievements of the year is the development of the super tension cable. France has 11.5 miles of 220 k.V. underground cable for transmitting electric energy through a densely populated suburban area in successful operation. This oil filled cable is capable of carrying 150,000 kVA; the charging kVA is 65,000. Great Britain has placed in commission an experimental length of nitrogen filled cable. The nitrogen gas has been operated at high internal pressures. Transmission by overhead lines of even higher voltages is in operation for a distance of 200 miles. Such high voltages are generally associated with long distance transmission where hydro electric power is available and do not come within the sphere of the municipal engineers of this country at this stage. We have ample coal supplies which are extremely cheap at the pithead but, with the high railage rates

CAPE TOWN'S NEW POWER STATION

Will have
a Waygood-Otis Passenger
lift in the boiler house.



Van Riebeck looks on
at a steadily growing Cape
Town — That Waygood Otis
lifts have played a big part
in this growth can be judged
by the fact that 85% of
Cape Town's lifts are by
Waygood-Otis.

on coal transported in our country, the costs are increased to such an extent that they tend to stifle industry depending on electricity supplies; it is therefore, not inconceivable that in certain situations high voltage transmission of power may be substituted for railway transported coal in certain areas in the future.

The changes and improvements which have taken place in the construction and operation of power stations is remarkable. The foresight, economic planning and action taken by Britain in encouraging the concentration of generation in fewer stations in groups operating large units on the base load principle has resulted in an improved form of efficiency and considerable economy in the cost of production. The growth of the size of alternators and amount of power distributed has raised many difficult problems, involving new designs of switchgear and methods of control and production, which have been ovecome successfully. Scientific research and design in production and industry have become increasingly recognised and co-operation continues to reduce the time lag between the scientific discovery and its industrial application in the manufacture and putting into operation of electrical machinery and equipment.

As municipal centres of population grow in areas and numbers, the problems of the municipal electrical engineer become of greater complexity, but as cheaper electricity supplies become available over larger areas the progress of the future will exceed that of the past. We have not reached the fringe of saturation point. It is the privilege and duty of the engineer to formulate schemes, give advice and endeavour to curtail the periods of waiting and possible unnecessary discussions which may cause undue delay. Our Association and these Conventions will continue to promote progress by the interchange of ideas and information, not only between engineer members but with our councillor members, creating a better understanding of the

problems to be tackled and co-operation in their solution to the benefit of the cities and towns we represent.

I wish to express my personal thanks in addition to that of the Council to our able Secretary, Mr. Poole, for the efficient and willing help given to us at all times. The sound state of the Association is largely due to his efforts and we record our appreciation of his unremitting attention and assistance.

My duties have been mitigated by the support of the Vice-President and Council, for which I thank them heartedly, and this valuable assistance we know will be extended in the same measure to our new President. (Applause).

Presidential Address.

by J. H. Gyles, M.I.E.E: M.S.A.I.E.E.
City Electrical Engineer, Durban.

I desire to express my appreciation of the great honour you have conferred upon me in electing me as your President for the year 1937/38. I am a comparatively new member of the Association, and am fully aware of the many difficulties of the position, in accepting which, I am relying on the support and assistance of all the members in order that I may worthily uphold the best traditions of the office so ably held by my predecessors.

These conferences are held not only that we may discuss our problems with our friends and develop our undertakings on the best lines to suit local conditions, but that we may endeavour as the years go by to attain to the ideal of common re-

gulations and conditions, which include, as far as practicable, a standardised system of tariffs of charges to consumers.

Many of you present here to-day will recall—with pleasant memories, I trust—the last Convention of this body held in Durban in December, 1924, nearly thirteen years ago. The number thirteen is popularly supposed to be closely associated with bad luck but the past thirteen years have certainly brought good fortune to Durban and its electricity undertaking. Our last Convention locally coincided with the first Electrical and Wireless Exhibition on a large scale to be staged here, as well as with the opening of the Broadcasting Station, the first municipally-owned establishment of its kind in the world. The Exhibition was the first step in the "All-electric Home" campaign which has resulted in our city becoming one of the most highly "electrified" centres, not only in South Africa, but probably throughout the world. It may be both interesting and profitable to look back for a moment to the year 1924 and visualise the progress that has taken place since that date. Statistics, so dear to the heart of every Engineer, show that the total sales of electricity for the Municipal Year ended 31st July, 1924, amounted to just under 42,000,000 units, while for the year ended 31st July, 1937, they totalled nearly 164,000,000. The maximum load on the system increased during the same period from 11,150 k.W. to 57,600 k.W , and the number of consumers from 13,712 to 31,353. Street lamps, another important indication of a city's progress numbered 3,487 in 1924, and 11,510 in 1937. In the former year there were 704 electric ranges, 796 electric water-heaters, and **no** electric refrigerators connected to our supply; at the end of July of the present year these figures had risen to 15 729 ranges, 8,116 water-heaters, and 10,564 refrigerators.

To satisfy the particularly financially minded, I must add a few extracts from the City Treasurer's Abstract of Accounts, these, it should

be noted, being for the years 1924 and 1936, the 1937 figures not being yet available in their audited form. Our revenue in 1924 amounted to £260,000 and in 1936 to £625,694. Our borrowing powers and gross capital outlay have both approximately doubled, the former rising from £1,050,000 to £2,200,000 and the latter from £983,716 to £1,834 005. The accumulations in Renewals Fund and Sinking Fund were respectively £229,670 and £91,814 in 1924, and £737,347 and £324,002 last year. The total contributions to the Borough Fund in relief of rates,—here I am aware I am treading on delicate ground — have risen from £365,075 to over the million mark—£1,053,875, to be exact, while the Working Balance Reserve increased from £20,000 to over £104,000.

The sales of current for all purposes given above as approximately 164,000,000 units (the actual number being 163,860,913) show when dissected under the various headings that private consumers' lighting, heating and cooking demands account for 55.1% of the total, followed by private power requirements, 28% of the total, Government consumption for lighting and power, 7.9%, tramways and trolley-buses 4.3%, street lighting 3%, and Municipal power and lighting 1.7%.

In 1924 all current demands were met by the Municipal Power Station at Alice Street, the negotiations being then in progress which led to the establishment of the Congella Undertaking of the Electricity Supply Commission, whose generating plant was put into commercial service on the 1st November, 1928. Prior to this the Municipality, in collaboration with Messrs. Huletts Refineries, Ltd., had inaugurated a waste-heat plant at the Company's factory at Rossburgh. This plant is still operating satisfactorily and economically to both parties, and extensions are at present under consideration. The Alice Street Station has for the past five years become a peak-load source of reserve plant during the winter months, and the wisdom of its retention was

proved as recently as the beginning of August, when a rainstorm of almost unprecendented localised severity temporarily placed the Congella plant out of service ,the Alice Street plant providing a limited supply which met the most urgent demands of our consumers until normal conditions had been restored.

The propaganda campaign for popularising domestic electrical appliances I have already briefly referred to, and in emphasising its remarkable success I may take this favourable opportunity of paying a tribute to the memory of my predecessor, Durban's first Borough Electrical Engineer, Mr. John Roberts, who passing at the age of 64 years took place since the last Convention of this Association. His name will go down as one of the pioneers of the electrical industry in South Africa, and the benefits he brought to this city alone it is difficult to estimate at their full value.

Municipally, much progress has taken place in the thirteen years we have been reviewing. In 1932 "Greater Durban" was created by the incorporation of certain of the adjoining suburbs and this has resulted in a large increase in engineering responsibilities, more especially in the civil engineering field, as the areas had been fully electrified prior to incorporation. Three years later, in 1935, the Borough of Durban, which had been created in 1854, blossomed into the full glory of a "City," and my position, along with that of other Municipal officials, was honoured with an amended title.

Another important local event in the engineering field was the extension last year of railway electrification to the port from the former terminus at Cato Ridge.

The habits of our residents, also, have changed in the period we are reviewing; they have become definitely electrically-minded, as already referred to, as well as car-minded and air-minded. The

ever increasing popularity of the motor car has vitally affected the municipal transportation system, and in turn detrimentally affected the tramway and trolley-bus load on the electrical mains. The migration of large numbers of consumers from self-contained homes to flats is evidenced by returns which I have received from the Building Inspector showing that for the year ended 31st July 1935, 66 plans were passed by the Municipality for new flats at an estimated cost of £408,070; July, 1936, 83 plans, estimated cost £418,606; July, 1937, 165 plans, estimated cost £734,070, or a total for the three years of 314 plans, to cost £1,560,646. This year's total of 165 plans allowed for 423 individual flats of one room, 607 of two rooms, 365 of three rooms, and 40 of four rooms. Similar stories could be told of every urban centre throughout the subcontinent represented here to-day, and they indicate a problem which we electrical engineers must face. Our domestic consumers may be said to have taken to living "in layers" instead of occupying houses and cottages as in past days when our tariffs of charges were formed, and these changed conditions will, I believe, eventually necessitate radical alterations in at least those two-part tariffs of charges for electrical energy whose standing charge portion is based on the rateable value basis, as I very much doubt if flat dwellers under such tariffs are bearing their fair proportion of those costs which the standing charges are designed to cover.

The question of the provision of reserve plant in power stations, and the cognate subject of the interlinking of stations, have become prominent both locally and elsewhere during recent years, and will tend to become increasingly so as time goes on and demands for cheap electrical energy continues to grow. While a few years ago some power stations had surplus plant installed, I believe that this is the case to a much less degree to-day, and with present prices of machinery and raw materials such as copper, generating condi-

tions would have to be particularly attractive as regards ample supplies of cheap fuel water, and land for extensions, to warrant heavy additional capital expenditure on any one station in order to augment the output of another station by the provision of expensive overhead or underground connecting lines between the two stations. Even where, as in the case of the suggested interlinking of the Colenso and Congella power stations of the Electricity Supply Commission, the provision of such lines would appear beneficial from the purely engineering point of view, the financial implications and the difficulties of arranging wayleaves along the most direct or convenient route often make it necessary to abandon projects of this nature.

While both urban and suburban street and road lighting has made great strides during recent years in this as in other countries, much yet remains to be done, and in this connection I feel that the time has arrived for the larger Municipalities to take up with the Provincial authorities the question of the subsidising of road lighting between the more important towns and villages. To take a case in point, let us consider for a moment the main road between Durban and Pietermaritzburg which, as is probably well known to most of us here to-day, may be looked upon as a good all-weather road, admittedly somewhat narrow in parts, and subject to heavy mist conditions at certain times of the year. While not suggesting that lighting might be provided of such intensity as to penetrate these mists or eliminate the dangers they present, the installation of road lighting on even a moderate scale would do much to improve both the safety of the route and the attractions of the drive by night. Were the Provincial Administration prepared to subsidise the Durban and Pietermaritzburg Municipalities and the Electricity Supply Commission, a scheme might be devised for each of these bodies to extend the road lighting from the nearest existing source of supply, and by the most

economical means, until the whole route was provided with illumination on a reasonably generous scale. While I have used the Durban-Pietermaritzburg section as an illustration, I feel sure that other engineers are aware of roads in their own districts, but outside their jurisdiction, carrying heavy traffic, the provision of adequate illumination along which would result in a reduction of the accident rate, and would be of considerable assistance to the pedestrian as well as to the motorist. I realise that he proposal contains many problems which render it difficult to effect but these have been overcome in other parts of the world, and they will have to be faced in this country sooner or later, so the sooner the better.

I would remark very briefly on a subject which has been very much to the fore in the past few years in overseas countries; I refer to the development of apparatus for the testing of the rupturing capacity of switchgear, one important effect of which has been the derating and rendering obsolete of switchgear equipments which have only been in service for a short time, and which when purchased were considered to be capable of taking care of any fault that could possibly occur in the particular position over a period of years, but which now as a result of the research and experiments that have taken place may be considered to be only capable of interrupting a fault of lesser magnitude. A temporary expedient which has been adopted locally to a certain extent is the transfer of such gear to a substation of what might be considered minor importance, in which the fault current to be interrupted is of lower value, and within the range of the derated gear. If this were not possible it would become necessary to make alterations in the amount of the Renewals Fund contributions in respect of all such gear as is likely to become "dated," and which cannot be used elsewhere, before the end of its original calculated life has been reached.

In my opening remarks I referred to the opportunity afforded by these conferences for the consideration of the problems with which we as engineers are faced; one of these problems is the question of the protection of the public from electric shock, and we have on the programme this year a paper bearing on this subject. In this connection there appears to be a considerable amount of misconception as to the extent to which fatal accidents are due to contact with live electric mains, and I am fortunately able to submit some official details in respect of the Union of South Africa which effectively refute the popular idea of the frequency of such fatalities. The figures cover all races and all circumstances falling within the purview of the Government Department of Labour. In the year 1932 only two deaths were caused by contact with electric mains, one being that of a painter working on the roof of a house who touched the service wires, and the other that of a linesman employed in the Durban Municipal Electrical Department who without any doubt committed a breach of the Department's printed instructions in working near high tension lines without taking the prescribed precautions. In 1933 five deaths occurred in connection with electric mains, comprising an European child who came into contact with live wires on a roof, an European woman electrocuted in a swimming bath, a labourer handling a defective electric lamp, and two workmen engaged in painting transmission line poles, no details of the circumstances being available. Five deathes also occurred in the year 1934 from electrical causes, being confined to children and members of the general public, one being a crane-driver who handled a trolley-wire which he thought had been switched off from the mains. In 1935 the latest year for which statistics have been supplied, four European were killed, two being boys playing on roofs, and one a builder carrying a damp piece of timber which came into contact with an overhead high tension line. The cause of the fourth fatality is not stated.

I do not propose to take up more of your time in view of the heavy agenda to be considered in the comparatively limited time at our disposal; I have merely touched on certain points which may be considered worthy of attention. In welcoming you one and all to our city, I trust that this Convention will be entirely successful in every respect; that its deliberations will be carried out in the spirit of toleration and harmony which has characterised previous Conventions; that we shall finally separate feeling that our time has been well spent, and that we shall return to our normal duties better equipped to serve our employers, the Municipal Councils and the ratepayers whom they represent, in the very import work of the supply and distribution of that vital factor in modern life—ELECTRICITY.

(The meeting adjourned from 11.5 a.m. to 11.30 a.m. for refreshments).

VENUE OF NEXT CONVENTION.

The President : We now come to the question of the Venue for our next Convention.

Councillor James (Capetown) : May I, speaking on behalf of the Mayor and the City Councillors of Capetown, extend to you an invitation to hold your next Convention in that City, and at the same time may I assure you that if you accept we will give you a very cordial, happy, and, we hope, a very interesting reception. (Applause).

Councillor Hofmeyr (Stellenbosch) : Perhaps you will allow me, Mr. President, to express the hope that when you come to the Cape next year Stellenbosch will be incorporated in your programme of enjoyment. When you were last in Capetown you afforded us an opportunity of entertaining you, and we would be very happy to do so again.

The President : We are very pleased to accept the very kind invitation of Capetown for next year's Convention. The visit there is sure to be most interesting and we are bound to enjoy ourselves and I hope it will be possible for us to pay a visit to Stellenbosch.

ELECTION OF VICE PRESIDENT.

I now call for nominations for the position of Vice-President.

Mr. Ewer (Pietermaritzburg) : I would like to propose Mr. Swingler (City Electrical Engineer of Capetown) as Vice-President.

Mr. Jagger (Ladysmith) : I have great pleasure in seconding that.

Mr. Swingler (Capetown) : I thank both my proposer and seconder for putting my name forward, but I have been President once. I have on my staff one of our members who has done much more for the Association than myself probably and I shall not feel in any way slighted if you would consider my colleague, Mr. Eastman, as Vice-President in place of myself.

Mr. Horrell (Pretoria) : Mr. Eastman has been a member of this Association for a considerable time, and has done excellent work, and while I personally would like to see Mr. Swingler as our Vice-President I do not think what he has said should be lightly set aside.

Councillor Middlebrook (Durban) : I think it would establish a most undesirable precedent were we to adopt the suggestion put forward by Mr. Swingler. The honour is one which should be borne by the chief executive of the Electrical Undertaking in the town where the Convention is to be held; therefore I cannot support Mr. Swingler's representations.

Councillor James (Capetown) : Mr. Swingler, with becoming modesty, has put forward the name of Mr. Eastman, and I for one can appreciate his point of view. As one who knows the close co-operation that exists between him and the members of his staff, I fully realise why he has put forward the name of Mr. Eastman. He has done so because he feels that it will be in the best interests of the Association that we should give an opportunity to a young and most promising member of this Association of being its President.

Mr. Ewer (Pietermaritzburg) : If it is the wish of the meeting I am quite prepared to withdraw my proposition. (Mr. Jagger, as seconder, also withdrew).

The President : The original resolution has been withdrawn, the proposal now is that Mr. H. A. Eastman of Capetown be elected Vice-President. Are you agreed?

Agreed.

ELECTION OF COUNCIL.

The President : The next item on the agenda is the election of two Councillor and four Engineer Members of the Executive Council.

Mr. Rodwell (Johannesburg) : The Association has received great help by having Councillor members on its Council. It gives the local authority Council members an opportunity to take part and assist, not only at the Convention's general proceedings but also in the work of our Council. It is desirable that representatives of the communities should take part in all these deliberations, to maintain continuity of interest.

I therefore propose as Councillor Members :—

Councillor Capell—Durban ;
Councillor James—Capetown.

This was seconded and agreed to.

Two alternatives, Councillor Middlebrook, of Durban, and Councillor Hofmeyr, of Stellenbosch were proposed, seconded and declared elected.

The President : I now call for nominations for four Engineer Members.

The following were duly proposed and seconded:

Messrs. Nicholas, Horrell, Harvey, Ritson, Pirie, Clinton and Newcombe.

A ballot being necessary, Messrs. Muller and Robbins were appointed scrutineers, and the following were declared by the President to be elected—

J. S. Clinton (Salisbury); L. L. Horrell (Pretoria); G. M. Pirie (Bloemfontein); A. Q. Harvey (Springs).

REPRESENTATIVE ON WORLD POWER CONFERENCE.

Mr. Horrell (Pretoria) : I have pleasure in proposing Mr. Rodwell of Johannesburg.

Mr. Pirie (Bloemfontein) : I beg to second.

Agreed.

REPRESENTATIVE ON SOUTH AFRICAN STANDARDS INSTITUTION.

Mr. Harvey of Springs being the representative in the past, was unanimously re-elected.

Councillor Middlebrook (Durban) : Could we perhaps have an account of his stewardship ?

Mr. Harvey (Springs) : All I can say is that these meetings are held every month. We go into various specifications and see how far they are adaptable for South African use. It is not necessary for me to go through the long list now. During the past year quite a number have been dealt with. The list is published in the proceedings of the Standards Institution.

Councillor Middlebrook (Durban) : I think it will be an advantage next year if we can have a report before us for consideration.

PAPERS SUB-COMMITTEE.

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

The following members were duly proposed and seconded :

J. H. Gyles—President;
H. A. Eastman—Vice-President;
G. G. Ewer—Past President.
E. Poole—Secretary & Treasurer.

Agreed.

GENERAL.

Councillor Spilkin (Umtata) : Under 'General' I wish to raise a matter of some importance, and that is in regard to some scale on which the salary of the Electrical Engineer may be based.

I feel that this Association has progressed in such a way and become one of the biggest in the country that the time has arrived when this question should receive proper consideration. I understand there is a salary scale drawn up by the Home Association based on the units consumed, and if it is good enough for other places it is good enough for us.

I therefore move that the Council of this Association consider this matter and further report.

Mr. Horrell (Pretoria) : I beg to second.

Carried.

Councillor the Rev. G. R. Veel (Kokstad : Under the heading "General Business" I would ask the indulgence of the conference whilst I men-

tion one matter of particular interest to the small towns represented here. It arises out of the able address of the retiring President, where he pleads for greater support for this conference on the part of smaller Municipalities.

I have made a rough estimate of the proportion of Electrical Undertakings supplying above and below 500,000 Units per annum, and I find that the figures are as 33 to 122. That is the smaller Undertakings are in a majority of 4 to 1; and a perusal of our agenda suggests that this majority may be only accademically, but not practically interested in the greater part of our programme.

On studying the preliminary agenda I realised that perhaps we ought to provide more time for the discussion of problems which are of practical interest to the smaller towns. For instance, on the agenda there are two papers which have special interest to the majority, but these are both relegated to the closing day, and there will be scant time to discuss them. Again, a very interesting paper deals with the progress and development of the Natal Undertaking (Colenso), but is of accademic rather than practical interest to the majority of smaller towns, which can never be on that particular supply. Then there is a paper dealing with Rate Relief, which can only interest a comparatively small number of Municipalities, and which appears to be a hardy annual. I hope it will be definitely disposed of at this Convention. (Hear Hear).

In the large majority of small Undertakings we are lucky if we even come out with even a very small balance to our credit. Subjects which can refer only to the larger Municipalities might still be dealt with at future Conventions, but at the same time I suggest there should be a duplicate session for the benefit of those who have very little interest in those particular subjects. We Councillors want to go back to our Councils with something practical to guide us in our work. For

instance, I thought we might very well have had a further profitable discussion on Mr. Milton's most interesting paper of last year. If, however, it is not possible to have duplicate sessions, it might still be possible to have more papers of special interest to the smaller Municipalities placed on the agenda; and to enable their being full discussed, the time allowed to the Convention might be extended by a day or two.

Many representatives here come from very far afield; and it must be disappointing to some who have journeyed so far, to find that the papers which are of practical interest to them are placed at the end of the agenda, and that there is no time for ample discussion. If we are to have papers that are of interest to large Municipalities only, then I suggest we should have (a) duplicate sessions, or (b) priority should be given to subjects of general interest to the majority, or (c) there should be an extension of the time allowed to the Convention.

Mr. Ewer (Pietermaritzburg) : As an alternative I suggest that we take Thursday's papers on Wednesday.

Mr. Rodwell (Johannesburg) : As a member of the Papers Sub-Committee, I would like to point out that all papers brought forward are considered fully, and when papers are received from the smaller towns, they are given a place on the agenda. It has been difficult to get sufficient papers from the smaller towns, and, therefore, papers from the larger centres have been presented.

Councillor Coetzee (Springs) : I would not like to see anything savouring of favouritism in connection with this matter. After all, the smaller towns must learn from the larger. Some attempt should be made to arrange the papers in such a way that particular subjects in which the smaller towns are interested might come up earlier on the agenda.

My impression is that the smaller towns receive quite as much attention as they are entitled to in regard to the various problems that arise. (hear, hear).

Mr. Sparks (Pietersburg) : As the engineer of a small Municipality, I would like to say how much we owe to the engineers of the larger Municipalities. It is quite true that many of the smaller towns are growing, but if we did not get the benefit of the advice and experience of the larger Undertakings how would we be able to meet the difficulties that confront us in connection with that growth and development ?

Mr. Nicholas (Umtata) : We come here to be educated from the experience of other engineers; we learn how their troubles are being overcome and thus we of the smaller Municipalities benefit materially. The same thing is happening in many other directions. Take, for instance, the motor trade and the development of motor engineering all over the world. I do feel that although the benefit of the papers we hear and discuss may not be felt now, we are being educated to perform our jobs more efficiently.

The President : I think we must thank Councillor Veel for the suggestion he has put forward. Personally I feel it would be inadvisable to make any alteration in the existing programme, which always receives the fullest consideration from the Council, but I think we might put Councillor Veel's suggestion before the Council, and if you agree to that course I will see that it is done.

Agreed.

The President : We will now adjourn until tomorrow morning at 10 a.m.

The Convention adjourned at 12.55 p.m.

TUESDAY, 9th November, 1937.

The Convention resumed at 10.10 a.m. in the Ball Room, Marine Hotel, with the President in the Chair.

GENERAL.

The President : The question has been raised of the annual Convention photograph and opinion has been expressed that it should not be taken. The matter was considered by the Council, who resolved to leave the decision in the hands of the members.

Mr. Rodwell (Johannesburg) : I think it would be a retrogade step to do away with the taking of the photograph, and I would like to move that we continue the practice.

This was seconded and agreed to.

The President : Yesterday the question of having duplicate sessions of the Convention was raised in the course of discussion. The Council has considered the matter and have unanimously decided to recommend that it would not be in the best interests of the Association to have duplicate sessions, and that the present policy be adhered to. (Applause).

Agreed.

NEW MEMBERS.

The President : Since the last Convention the following new members have been added to the register :—

Mr. C. Runtzler (Port Shepstone).
Mr. M. M. Smith (Matatiele).
Ladybrand Municipality.

(Applause).

The President : I will now ask Councillor James, of Capetown, to read his paper "A Review of the Policy of Rate Relief from Municipal Undertaking Funds."

At the request of Councillor James, his paper was read by Councillor Hofmeyr (Stellenbosch).

A Review of the Policy of Rate Relief from Municipal Electricity Undertaking Funds

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by Councillor W. James.
Chairman of the Electricity and Waterworks Committee,
CAPETOWN.

INTRODUCTION :

THE question as to the extent to which, if at all, Municipal Electricity Undertakings should be called upon to contribute towards the relief of the general Municipal rate has been raised at several of the annual conventions of our Association, but as far as the author is aware this is the first occasion on which the subject has been ventilated in the form of a paper. It is a question of such importance to, and is a problem of such difficulty in, many Municipalities that the author has accepted an invitation to submit a paper on it in the hope that the points which he has raised and others which doubtless will be raised in the ensuing discussion will assist in making for that better understanding of a subject which is at the present time so contentious and on which so much misapprehension exists.

Because of the far reaching effects of the application of the principle of rate relief by this means it is not surprising that very strong opinions should be held on it, but it is remarkable to find that they range from demands for its total abolition to its wholehearted adoption regardless of considerations of the financial position of the Electricity Undertaking which has even gone so far within the author's personal knowledge as a deliberate disregard, (as a matter of financial expediency of the moment) of advice from a financial expert whom the Council had specially appointed with that as one of the main questions for his considerations.

GENERAL CONSIDERATIONS :

For the purpose of this paper, rate relief is taken to refer to the use of the Electricity Undertaking as a means literally of relieving ratepayers of the obligation to pay on rating account the sum necessary to balance the general fund revenue with expenditure on all Municipal services taken together excluding that of the supply of electricity. Such relief is most obviously obtained by requiring lump sum payments to be made from the Electricity Undertaking to general fund revenue and less obviously though none the less effectively, by requiring the Electricity Undertakings to provide public and inter-departmental services at less than cost.

The time has long past when the supply of electricity was a luxury within the reach only of the more affluent citizens, or even a desirable amenity for those who can afford it, for present-day conditions of living have brought the supply of electricity into the category of a public service which is necessary for the health and general well-being of a community, whilst industrial activity is impossible on a large enough scale to provide outlets for employment sufficient to establish and maintain economic conditions at the

standard now required unless supplies of electricity are made available to virtually an unlimited extent at low cost.

Many of the services rendered by the supply of electricity are such that they cannot be provided by any other means. In other instances the supply of electricity has active competitors, although perhaps the competitive services may be accomplished by less convenience and diminished security of supply, such as for example, in the use of fuel for heating and power production in individual plants.

It is a common experience that when the matter of taking a supply of electricity from the public mains is being weighed up against the use of fuel or the installation of a privately-owned plant for the same purpose the question of cost is the prime consideration, and while an individual instance of this kind might at first sight seem to be of no particular consequence the fact remains that any one decision against taking supply from the public mains creates a setback to the development of the undertaking, for the fewer the consumers the smaller the quantity of electric energy sold and the greater the difficulty in maintaining prices for electricity at sufficiently low figures to attract more consumers and increased sales.

The efficiency of plant and equipment for the production of heat and power by means other than electricity is steadily being improved, so that any action which results in keeping the prices charged for electricity at a higher price than is necessary to cover expenditure and to safeguard the financial stability of the concern is fraught with danger of cessation of development if not with the actual loss of business. In other words, in order that the Municipal Electricity Undertaking should properly fulfil its function of making available to the grestest number the benefits of the use of electricity it should apply in every

possible direction conservative business principles to the operation of the undertaking with the object of providing the service at the lowest possible cost and of paying dividends through the increased rateable valuation of the district served which the existence of such an undertaking brings about rather than tangibly, for example, in cash.

Thus, assuming that adequate provision has been made for depreciation and obsolescence of plant and equipment and to secure the undertaking financially against adverse circumstances or unforseen contingencies, rate relief must of necessity have the effect of keeping the price of electric energy at a higher price than that at which it **could** be sold, and the problem to be solved boils down to a judgment of the extent to which tariffs may be maintained at that higher price without incurring the dangers which have been referred to. A little consideration of what is implied in this will, however, show that it places in the background, if it does not entirely ignore, the claims of the poorer sections of the community to partake of the benefits of the use of electricity. Notwithstanding the obvious disabilities in which an electricity undertaking is placed through these "adequate provisions" not being made, the temptation to obtain "easy money" has indeed proved so irresistable in many undertakings that it has been considered desirable in some countries to control such action by legislation.

EQUITY :

It may be of interest at this point to examine the policy of rate relief from the standpoint of equity. The question of equity arises partly through the fact that the whole of the funds of an electricity undertaking is obtained from one section of the community, namely, the electricity consumers and who, it should be noted, are not necessarily all resident in the Municipality owning the electricity undertaking and partly from the fact that the greater the use made of the electricity undertaking by an individual the more

heavily is he required to contribute indirectly towards the total Municipal expenses. All ratepayers are not necessarily consumers of electricity, whereas all electricity consumers are ratepayers either as owners of property or through the rent which they pay to their landlords, and where the policy of rate relief is in force they pay **additional** rates through their electricity accounts. The objections to the policy where the consumer is a ratepayer in an adjoining Municipality are so obvious as to be self-evident, and in passing I would mention that these may well prove to be the cause of very material modification of the policy of such rate relief as is now permissible by law in Great Britain in the event of the principles of the McGowan report relating to the amalgamation of electricity supply undertakings in that country being made the subject of legislation. Thus the policy of rate relief not only discriminates between sections of the community by placing a heavier burden on one of them but also discriminates between members of the section by requiring those that make most use of the electricity supply service to carry the greatest weight, although the main function of that service is to provide benefits to the community as a whole.

As an illustration of the effect of putting the policy of rate relief into force one might consider the case of two industrial consumers "A" and "B", the valuations of whose properties are the same and whose businesses are both of the same nature, but whereas "A", whose electricity account is £250 per annum makes use of one or more of the competitors of electricity in his manufacturing processes, "B", who draws upon the public supply for the whole of his factory requirements, has an electricity account amounting to £500 per annum. Taking also an actual instance within the knowledge of the author of a contribution towards the relief of rates of an amount which is 14½% of the revenue from the sale of electricity, it will be obvious that 14½% of "A" 's payments for electricity, namely £36, is being used to finance other

Municipal enterprises, while £72. of "B" 's payments for electricity go the same way. If the Municipal electricity undertaking did not exist these two consumers would be required to pay the same annual sum in the shape of rates as a contribution towards the general Municipal expenses, but merely because of the fact that the electricity undertaking is owned by the municipality and is patronised by "B" to a greater extent than "A" the latter is called upon to pay £36 more per annum towards the general Municipal expenses than "A" and is in fact financing to quite an appreciable extent overhead costs which should be paid by his competitor. If the policy of rate relief were not in force, however, both "A" and "B" would pay an equal amount more in the shape of general rates, but the cost of electricity to both could be reduced. In that case "B", because of his greater consumption would obtain the greater benefit to which incidentally he is entitled because of his supporting the undertaking to the greater extent.

In the same way a domestic consumer in an "All-electric" house where rate relief is in force pays far more towards the Municipal expenses than a consumer occupying a house of the same valuation who uses electricity only for lighting purposes and perhaps for an electric iron or kettle and depends on gas, oil, coal or wood for heating and cooking.

Indeed the extent to which owners on a large scale of rented properties and undeveloped land stand to gain in this way in such that it is not at all surprising to find that they constitute the most ardent supporters of the policy.

FINANCIAL SECURITY :

That to give effect to a policy of rate relief when this cannot be afforded will inevitably lead to a restriction of the development of the undertaking if not to actual financial difficulty, is so self-evident as scarcely to be worthy of drawing

attention to its dangers, were it not for the fact that on the one hand such a policy might be put into effect without the Council being aware of the circumstances and that on the other hand Municipalities have in some instances paid so little regard to them that the sum taken from the undertaking has exceeded the gross profit whereby a deficit was carried forward to the following year and have even repeated the action to an increased extent at the end of that period.

Indeed it is obviously an essential pre-requisite that no rate relief be made except from a surplus and that that surplus is a true one. That is to say it is a surplus which remains after proper allowance has been made for charges external to actual working costs in the shape of provision for redemption, interest on loans and above all for depreciation and **obsolescence** of plant and equipment.

Emphasis is laid upon the last mentioned items for the reason that whereas to a very great extent the allowances made for them leave scope for variation according to personal opinion and the exigencies of the moment, the former are fixed by the terms and conditions under which the loan monies are raised.

The existence of the scope for variation in the provision made for depreciation, obsolescence and reserves is the main factor in making it possible to show a surplus from which rate relief may be effected although the actual financial position may by no means be as satisfactory as one might be led to believe from the net profits shown in the accounts.

Whilst detailed consideration of the questions involved in such financial provisions is outside the scope of this paper their influence in making rate relief possible to an unwise degree makes it desirable at least to point to their importance.

In every progressive electricity undertaking it is unavoidable that capital charges expressed as an average cost per unit go through a succession of cycles of sudden increase and slower progressive decrease and this is especially noticeable in the case of power station plant and transmission systems when large capital expenditure may have to be incurred several years ahead of actual load requirements.

Moreover although assets, on which large sums may have been spent in obtaining the best of their kind **available at the time,** are kept in first-class condition, they may well be rendered of little use to the undertaking in less than one half the time they were in the first place expected to give useful service because of, for example, the rapid improvements which are constantly being made in such plant or their unsuitability for unexpected developments in load requirements.

Obsolescence thus may be likened to a hazard that is known to exist but whose effects cannot be foretold with any degree of accuracy, and it therefore behoves those responsible for the finances of an electricity undertaking to protect it against the worst that may happen. Not to do so merely invites the risk to materialise of the undertaking finding itself faced with heavy additional capital charges on expenditure from new loan funds for replacing plant which may still be in good working order but inadequate for the requirements. The burden imposed on an undertaking by this state of affairs is the heavier when, as is the case in many undertakings in this country, the period of the redemption of the loans raised bears no relationship to the useful life of the plant and equipment purchased for in that case capital charges may have to be paid in respect of plant long after it has ceased to exist and **in addition** on plant which has replaced it. Moreover where monies have been provided for rate relief that on a more conservative financial outlook should have been put back into the business, the

loans which are raised from time to time to finance extensions must obviously be just those amounts greater than otherwise would be sufficient for the proper development of the undertaking.

As a numerical example of the way in which capital expenditure from loan monies has the effect of increasing the annual charges, consider an expenditure on plant of £100,000 from a 40 year loan bearing interest at 3½%. The annual interest charges alone on this sum will amount to £3,500 or a total over the whole repayment period of £140,000, that is to say that the total production costs over the whole loan period are increased by £140,000 in respect of this one item of expense if the plant is purchased from loan monies rather than from a fund established from surplus revenues.

The example thus serves as a striking demonstration of the savings made possible by utilising surplus revenues—always bearing in mind that the tariff rates for electricity must also be kept low enough to encourage expansion—for the purpose of building up a reserve fund to meet capital expenditure for which otherwise loans would have to be raised. Applied in this way surplus revenue can lead to a reduction in capital charges to an extent which can make possible further reductions in the tariff rates and at the same time improve the financial stability of the undertaking.

Before leaving this subject it may be of interest to record the views expressed on it by the consulting engineers to the Capetown City Council in a report written in 1932 when they said—

> "As regards financial matters, however, we think it well to make some observations on the question of allowance for depreciation. The business of electricity supply has one very striking characteristic as compared with many commercial businesses, namely, the very high ratio of

capital to turnover. Practically every development in the direction of reducing the cost of electricity to the consumer has been accomplished by the substitution of capital expenditure for running cost.

"The question of adequate depreciation is therefore of greatest importance to an Electricity Supply Undertaking. Electricity has no monopoly either for lighting, heating or power, but must compete with other forms of energy, perhaps less convenient but still available at an economic price. It is therefore important to avoid getting into the unfortunate position which has been reached by the railway companies particularly in Great Britain and to a large extent throughout the world where large amounts of capital have been expended and never adequately written off, whilst serious competition has now to be faced from road transport."

It will be seen therefore that the financial position of any electricity undertaking is indicated not so much by the surplus shown in its revenue expenditure accounts as by the extent to which reserves have been built up.

In passing it might be observed that it is becoming increasingly realised by those responsible for the financial control of electricity undertakings that the figure which gives at a glance the position in regard to financial security is the ratio of the net loan indebtedness to total capital outlay, and that the aim is to keep this ratio small. For the figure to be zero is an impossible ideal, but it is significant that in the most progressive of Municipal Undertakings the ratio ranges from about 0.3 to 0.4.

Finally, to give rate relief from surplus revenues to such an extent as to make it necessary to raise loans virtually for every extension of any consequence or to do so well knowing that it will entail the raising of loans unnecessarily or avoidably is akin to raising loans indirectly for the relief of rates, the wisdom — apart from the legality—of doing which is very much open to doubt.

REWARDS TO RATEPAYERS :

The argument most frequently adduced in favour of rate relief is to the effect that ratepayers are entitled to a return on the investment in the electricity undertaking for which they stand as guarantors.

The argument is, however, unsound for the reason that the ratepayers guarantee only the payment of interest on the capital invested in the undertaking, but in lending their credit in this connection they do so not as individuals but as a corporate body for the benefit of the district as a whole. Moreover, they do not collectively, and not even necessarily individually, provide any of the capital itself since this is found by investors in Municipal stocks who may have no other financial interest in the Municipality at all, nor do they pay any of the interest since this is paid by the consumer of electricity.

Even conceding that the ratepayers are entitled to some remuneration for guaranteeing the payment of interest, the claim can be equally strongly pressed that their reward consists of their becoming the **owners of an asset for which they have not paid anything,** in the shape of the increased wealth of the district due to the trades and businesses built up with the aid of electricity, in the increased rateable value of the district and in the general improvement in the conditions of living rendered possible by the use of electricity.

The maximum advantages accruing to the ratepayers in this direction can only be obtained in fullest measure, as mentioned elsewhere in this paper, by supplying electricity at the lowest possible price and by dealing with the finances of the undertaking on sound business lines, namely, by conserving the assets and investing surplus profits in the business. By acting in that manner the risk of ratepapers having to meet a deficit on the undertaking is amply guarded against and the undertaking is placed in a position to be de-

veloped in such a way as to enable advantage to be taken of the improvements which are being made so rapidly in the technique of the generation and distribution of electricity, thereby still further enhancing the value of the undertaking to the ratepayers as a whole and at the same time eliminating the supposititious risk run by them in lending their credit on which the capital is borrowed.

It is also sometimes claimed that on account of the ratepayers guaranteeing the payment of interest the municipality is able to obtain loans for its electricity undertaking at a lower rate of interest than that at which they can be obtained by private concerns and that accordingly the difference in the interest rates is the ratepayer's property. If such be the case under the present-day conditions (which I doubt) there may be something to be said for the contention, but on the other hand it may be claimed with equal force that in the interests of the ratepayers what reduction in interest charges are obtainable in this way ought to be used to provide a more substantial fund to cover depreciation and obsolescence than a privately-owned undertaking might consider necessary and in that way still further secure the undertaking against it ever becoming a liability with which the ratepayers might find themselves faced at some future date.

That the advantage in favour of a Municipality in respect of lower interest rates on loan monies is in any case a very small one is evidenced by the fact that the Electricity Supply Commission in South Africa — a corporate body which raises capital for the expansion of its activities without backing by the Government for payment of its liabilities—has shown that it is consistently able to raise money for electrical development purposes within one quarter of one per cent of the interest rates payable on loans raised by large municipalities, the payment of the interest on which is guaranteed by the municipality as a whole, and

recent experience in this connection has shown that a large municipality at the present time has no advantage over the Commission in this respect.

The claims for rewards by ratepayers in some instances take the form of a demand for the payment of rental or wayleaves for the use of the streets in which cables are laid or along which overhead lines are erected.

Such claims ignore the fact that a supply of electricity in any municipality is just as essential for the general well-being of the community as for example the public supply of water and the reasonableness or otherwise of the claims can readily be tested by considering whether they could be applied also to water mains laid in the streets occupying as they do, on the average more of the streets and introducing a greater risk of damage to property than electricity conductors.

In passing, as an indication of the general policy in this matter in South Africa contemplated by the Electricity Act it might be mentioned that in terms of the Act any authorised undertaker may obtain the right to lay cables or construct electric transmission lines under or along any streets in a local authority's jurisdiction without being required to pay anything beyond the cost of opening up for the purpose and later restoring the streets to their original condition.

LEGISLATION :

The problem under discussion is not peculiar to municipalities in South Africa but inevitably arises in every country where Municipal Electricity Undertakings exist. For example, legislation to prevent rate relief to an inordinate and unwise extent is included in the provision of the Electricity (Supply) Act 1926, Great Britain, a measure which was introduced to promote the expansion of the use of electricity in that country. The importance with which this subject was

viewed by the Government is illustrated by the statement by the Minister of Transport during the discussion on the Bill :—

> "We are now dealing with an Electricity Supply Bill, the object of which is to cheapen electricity. We say that the first charges on the benefits which are received from this Bill on the net surplus should go to the consumers who provide the profits and not to the rates as heretofore. We have taken steps in this Bill to restrict the profit of the Company so that the consumer may be protected and the House will think it only fair and right that the consumer should get the benefit of the Bill and not the ratepayers as a whole."

The Act as passed contains the following provisions :—

> "The undertaking shall apply the net surplus remaining in any year and the annual proceeds of the reserve funds when amounting to the prescribed limit :—
>
> (a) in reduction of the charges for electricity; or
>
> (b) in reduction of the capital monies borrowed for electricity purposes; or
>
> (c) with the consent of the Electricity Commissioners in payment of expenses chargeable to Capital; or
>
> (d) in aid of the local rates ;

Provided that—

> (i) the amount which may be applied in aid of the local rate in any year shall not exceed 1½% of the outstanding debt of the undertaking, and
>
> (ii) after the 31st day of March, 1930 no sum shall be paid in aid of the local rates unless the reserve fund amounts to more than 1/20th of the aggregate capital expenditure on the undertaking."

from which it will be seen that while rate relief is not entirely prohibited, the Act advocates returning any surplus profits to the consumer and what rate relief may in terms of the Act be given, is limited and is regulated so that no adverse effect will be caused thereby on the financial security of the undertaking.

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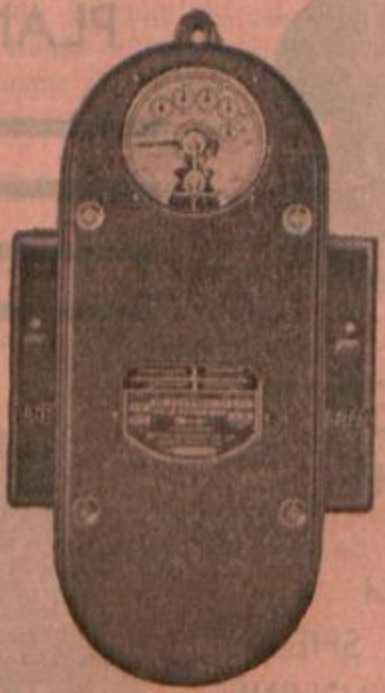

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It is interesting to note, however, that before this Act was passed some of the largest and most progressive electricity undertakings in Great Britain, such as Glasgow, Hull, Manchester, Bolton, Dundee and Edinburgh, had resolved to retain all the profits from the sale of electricity for the benefit of the undertaking and the consumers, and that the electricity undertakings of Birmingham, Coventry, Leicester, St. Marylebone and Stepney had only occasionally given effect to the policy of rate relief.

The question was dealt with in America in 1934 in the following pronouncement by the New York Public Service Commission when an application was made to it by a municipality for permission to contribute towards the relief of rates from profits from its electricity undertaking :—

> "The purpose for which municipal corporations are created and governmental powers are conferred upon them is in direct opposition to the theory that profit should be made out of their operations. The main purpose of private corporations is to obtain profit and it is only because public utilities operate plants which are essential to well being and can exist only through unusual powers conferred upon them that they come under public regulation and their profits limited through the police power of the State. Governments exist for public well being, they are not created for the purpose of making profits . . . . . It may be that in the interests of conservative financing, the obligations issued to build a plant should be gradually reduced and ultimately retired, but if this course is followed there is no reason in justice or equity why consumers should then be required to pay rates which are in excess of the cost of the service in order that taxpayers may be benefited or that funds may be provided for extra legal municipal functions. When once the consumers have paid for the property out of rates (of charges for electricity) and public funds obtained from other sources have been fully reimbursed for all possible charges or advances, there should be an end to capital charges."

In this case again the tenor of an important regulatory body is to the effect that Municipal Electricity Undertakings should not operate at a profit and that the tariff of charges should be fixed no higher than is necessary to yield sufficient revenue to cover the total cost of operation and the appropriate capital charges.

In the Union of South Africa the principle of returning only to consumers the benefits of economies in the operation of electricity undertakings is enshrined in the Electricity Act No. 42 of 1922, under which the Electricity Supply Commission is required to regulate its charges at its various undertakings so that it shall make neither a profit nor a loss and which prescribes that other licencees under the Act must distribute annually amongst their consumers, pro rata to their payments for electricity supplied, 25% of the surplus profit of their undertakings for that year.

Whilst at the present time no legislation exists in the Union of South Africa regulating this policy in respect of municipalities it is interesting to know that recently it was proposed to do so by Cape Provincial Ordinance. A draft of that section of the Ordinance which relates to this subject was published in the Cape Provincial Gazette on the 19th May, 1936, as follows :—

> (1) The Council of a Municipality operating an electricity undertaking may apply a portion of the net surplus revenue thereof in any financial year as a contribution in aid of the general landlord's rates.
>
> (2) No such contribution in aid in terms of subsection
>
> (1) shall be made unless—
>
> (a) the Renewals and Obsolescence and the Reserve and Betterment Fund of the undertaking together amount to more than 1/20th of the total capital expenditure of the undertaking as appearing in the balance sheet thereof as at the close of the preceding calendar year, and

(b) it is supported by a resolution of the Council passed by a majority of the total number of members of the whole Council.

(3) The amount of any contribution in aid made in terms of this section shall be clearly and prominently set forth in the annual accounts of the undertaking laid before the Council and in the certified statements or abstract thereof available for inspection by ratepayers and other interested persons in terms of any law.

(4) where in the opinion of the Administrator the amount applied by any Council in terms of this section in any year is unwarranted or excessive, such Council shall be advised thereof, and the Administrator may direct that for a specified period thereafter no further contribution in aid shall be made without his prior approval in writing. Such approval may be given conditionally or unconditionally, and shall be in addition to the requirements of subsections (2) and (3).

I understand that consideration of this section of the Ordinance was postponed upon representations made on behalf of the City of Capetown but its publication is significant of the feeling which prevailed in the Cape Provincial Administration that statutory regulation of this matter was desirable.

GENERAL :

Apart from the question of equity and financial security of the undertaking referred to in the earlier part of this paper, the wisdom of relying upon profits of a trading undertaking for the relief of rates is open to doubt, since it is a form of taxation which cannot be relied upon to give a steady income for the reason that profits on trading undertakings may be expected to vary according to the general state of trade.

If, therefore, a municipality has relied on the relief of rates to any substantial extent from such sources, it may then happen that this source dries up during periods of depression and these are as a rule the very times when such relief of direct taxation is most to be desired by ratepayers.

It is obvious that if the funds of an electricity undertaking are available to make up deficiencies in other municipal accounts, the result of the adoption of such a policy may well tend to nullify a policy of economy in municipal administration and to a great extent might even be said to encourage extravagence in, for example, embarking upon schemes which are not self-supporting financially and which probably would not have been undertaken if to do so would have necessitated obtaining increased revenue through the general rating account.

Further the knowledge that profits are to be drawn upon to finance municipal enterprises not in any way connected with the electricity undertaking has a psychological effect in discouraging the making of maximum economies in its operation.

One great danger in this matter is that when once a contribution has been made to the rates from funds of the Electricity Department, the responsible Committee usually finds it impossible to refuse the next demand however badly the money is wanted for departmental purposes and it is not unknown for the demand even to be sustained by a Council contrary to the wishes of that Committee.

In conclusion in order that it should not be thought that in the Author's opinion the Electricity Undertaking should in any way receive preferential treatment over other Municipal Departments, he wishes to make clear that he holds it to be in the best interests of any municipality that its electricity undertaking be developed and be permitted to develop on the lines of a business undertaking to the extent that it should be required to give services to other branches of the Municipality concerned at ordinary tariff rates and similarly it should pay for services which it receives from other departments at the ordinary rates applicable to such services, thus the cost of street lighting should be paid for at the actual

cost of providing that service and vice versa the electricity undertaking should be required to pay municipal rates and water rates on the same scales as apply to any other ratepayer.

The President : Gentlemen, we have to thank Councillor James very much indeed for his most valuable paper, and also Mr. Hofmeyr for reading it. Before the discussion we will have an interval for refreshments.

The sitting was resumed at 11.30 a.m.

DISCUSSION :

Mr. Foden (East London) : I desire to congratulate Mr. Councillor James upon his very able and timely paper. The subject of Rate Relief from Electricity Revenue is a most contentious one between Municipal Engineers and their respective Councils and it is very heartening to Engineers to have a Councillor taking up the cudgels on behalf of the Engineers and so adding considerable support to the theories put forward by them.

Regarding the draft of the proposed Cape Provincial Ordinance which appeared in the Cape Provincial Gazette in May 1936. Assuming for the moment that this had become law it would have benefitted many Electrical Undertakings in so far as limiting their contribution to the General Fund, but I am in total agreement with the author that it is not sound finance to rely upon the profits of Municipal trading concerns for the relief of rates for the reasons put forward in his paper, i.e , the unreliability of trade with its phases of prosperity and depression. I do not wish to take up the time of this Convention by reiterating the author's statements but I do wish to amplify my remark "timely paper."

The author in the 3rd and 4th paragraphs of his paper under the heading "General Considerations" has, I consider, touched the keynote. These

paragraphs should give rise to serious reflections by many Councils on the subject of rate relief for the following reasons.

Competition in the supply of power in many towns in the Union is non-existent and therefore the Electricity Undertaking has a monopoly. In many cases this monopoly would appear to be the subject of exploitation.

We are passing through a period of remarkable scientific discoveries and who can say what scientific research will discover in the methods of producing power ? Primarily we must remember that with internal combustion engines, high thermal efficiency is **not** confined to large plants as is the case with steam electric power stations.

Take the cost of heat, which heat may be produced by either electricity, gas or oil fuel.

On the basis of ½d. per unit for electricity we obtain 6,824 B.Th.U. for 1d. For Gas at 6d. per therm. we can obtain 16,600 B.Th.U. for 1d. and for oil at 80/- per ton we can obtain 44,500 B.Th.U. for 1d. Therefore, to compete with gas on a B.Th.U basis it would be necessary to sell electricity at 0.203d. per unit, and in the case of oil, it would be necessary to bring the price of electric current down to 0.077d. per unit.

I would refer members to the Journal of the Institution of Electrical Engineers No. 436 which contains a paper entitled "The Relative Fuel Economy of Electricity, Gas and Oil" and I acknowledge quoting the above figures from this paper.

As an Electrical Engineer I obviously cannot champion the claims of gas or any other source of power with or without its resultant by-products. We know South Africa is a young country industrially and as it develops, the various industries may provide very cheap power as a by-product,

for instance the waste products from coke ovens, producer gas, etc., this quite apart from the installation of private plants which may consider process steam in their power plant lay-out.

I therefore reiterate that Mr. Councillor Jame's paper is very "timely" for should some other source of power be developed or discovered and electric power not take major place as we all, I hope, consider it does at present, then the various Electricity Undertakings may be faced in the future with a heavy burden in the form of interest on capital expenditure on plant which has become obsolescent.

A similar analogy would be the position of transport undertakings where trams have been replaced by petrol engined buses and later compression ignition buses.

To quote an old tag "It is the swing of the pendulum."

In conclusion I heartily endorse the principle of the author's paper and consider that only a small percentage of the profits made by the Electricity Undertaking should be confiscated for the relief of the general ratepayer and then only as a last resort. The Electricity consuming ratepayer should have the benefit in the form of lower tariffs. This would serve a twofold purpose, viz :—

(1) Tend to eliminate or reduce competition from any other source of power.

(2) Assist the growth of the town by offering low electricity traiffs which in turn attracts industries and consequent increased population with their potential electricity consumption.

Given the population, the business of the Electricity Undertaking is to educate the population in the uses of electricity by drawing their attention to the slogan adopted at East Landon.

"ALWAYS USE ELECTRICITY ALL WAYS"

(Applause).

Mr. Rodwell (Johannesburg) : This paper deals with a subject which has been before our Association for many years. In many instances the City and Town Council's views on this subject do not coincide with the views of their financial advisers and engineers, and, therefore, there is a reluctance on the part of some of our members to discuss the question. It is an axiom that inter-departmental and public services should not be supplied at less than cost, and, conversely, this implies in equity that public services should as far as possible be furnished at cost after provision has been made for interest and the redemption of loan monies, together with adequate reserves. As pointed out in the paper, regulations have been enacted in other countries to give effect to this. The application of new discovery to manufacture and design may at any time upset the basis of established methods, and I was pleased to note that the author emphasised the need to provide for possible obsolescence of plant and equipment. The paper is valuable because it correlates facts in a precise and unbiased way, giving a complete review of the problem and its effects, from which it should be possible for each reader to draw his own conclusions.

Our thanks are due to Councillor James for this important paper for our use, guidance and discussion, and which will form a valuable contribution to our proceedings. (Applause).

Councillor Smit (Bloemfontein) : I did not intend speaking on this subject this morning as on the three occasions I have attended this Convention there has been such an overwhelming disposition to support the view contended for by Councillor James that I hardly thought it worth while.

One cannot cavil at any profession seeking to protect its own interests within legitimate limits but the attempts on the part of the Electrical Engineers and Mr. Milton of the Electricity Supply

Commission to curb the activities of local authorities so far as electricity profits are concerned have, so it seems to me, almost become an obsession.

Municipalities are trading concerns whose ramifications in many instances are so wide as to cover anything from the proverbial needle to an elephant. Some of the departments such as electricity for example are profit making whilst others are wholly unproductive but nevertheless vital and essential in providing the multifarious amenities which are necessary concomitants to any progressive town or city.

Let us approach the subject from its source by providing a somewhat primitive example. Suppose all of us as business men decide to establish a township on Robben Island, and being the owners of property therein one of our first ventures is to establish an electric power station. The undertaking after making adequate provision for redemption and interest, obselescence, depreciation and all other contingencies shows a nett profit of £5,000 0s. 0d. Our properties are already rated but we require funds for kerbing and channelling, bituminous roads, better health provisions and so forth. There is no other fund from which we can draw. The question I ask is why should we not raid the electricity profits for this purpose while your answer is that only a limited amount may be taken and for the rest we must raise a loan. If this operation is repeated often enough we must inevitably be faced with soaring rates and thereby deter many prospective citizens from settling in our little community.

Again, our mythical town is expanding. It has become a large educational centre and a mecca for tourists, bringing in its train various commercial and other interests, all tenanting the buildings we have erected. In keeping with the progress of the town other and additional amenities must be provided involving heavy capital expenditure. But

although the Electricity Undertaking is flourishing we can take only a limited amount of the profits and once more we are forced to raise a loan involving the levy of an additional rate. If the landlord complains that the rates are too high he is met with the reply that he can raise his rent. Indeed he is obliged to with the result that the benefit the tenant derives from cheap electricity is offset by increased rent. I should like Councillor James in his reply to show what reactions are likely to follow the adoption of his proposal. It is all a vicious circle and whatever scheme is evolved I am afraid you will always be faced with this difficulty that what you give with the one hand you are bound to take away with the other.

Mr. Horrell (Pretoria) : I would like to add my congratulations to Councillor James on the excellent paper which he has presented and the able manner in which he has marshalled his arguments.

The subject of his address has become a hardy annual at these Conventions, and has probably proved to be the most contentious matter with which we have ever dealt. It seems to me that the time has arrived when we should give some lead to the Councils on this matter, and I feel that we can present a reasonable solution. (hear, hear).

If we examine the pros and cons we find that those who favour the policy of rate relief from Municipal Electricity Undertakings use one or more of the following arguments or some combination of them :

(1) Money borrowed by a Municipality for its Electricity Undertakings is guaranteed by the property owners and it is only right therefore that they should receive some benefit for the security proprovided and which is made use of by the electricity consumer. That is the property owner is in the

position of a shareholder and considers himself entitled to a dividend.

(2) Modern Civic Government has to provide a Municiplicity of amenities some of which can be supplied on a paying basis; others on a partly paying basis and some at a profit, and it is sound finance and logic for the Council to "make up on the swings what it loses on the roundabouts."

(3) If the Council are not permitted to make profits from Electricity and other Undertakings, property owners will refuse to pay higher rates in order to provide amenities which can only be supplied at a loss, thereby hampering the progress of the town and causing the Electricity Undertaking to suffer because of all-round lack of progress.

(4) It is argued that since Electricity Undertakings in South Africa show rapid progress in spite of the substantial sums transferred in relief of rates, the present tariffs are not too high and do not hamper industrial progress.

(5) It is also urged that since electricity is no longer a luxury but is a necessity and is used by almost everybody, it is sound to levy a small tax on electricity consumers through the tariff and in this respect a parallel is often drawn through the indirect taxation levied by the Government to keep down direct taxes such as income tax.

(6) A further argument used is that since domestic consumption forms an appreciable portion of the total, a reduction in domestic tariffs would have no effect on industry while the increase in rates necessitated by reducing the profits on electricity supply would be felt immediately by industry and hamper progress.

(7) Municipal Electricity Undertakings do not, as a rule, pay rates while they receive the benefit of many services such as roads, publicity, financial and secretarial work, for which they should pay in some manner or other.

I do not intend to debate the accuracy or otherwise of these arguments, but will pass on now to those used by the opposite camp against the policy of relief of rates. They contend that :

(1) When profits from Electricity Undertakings are taken to relieve rates, there is a tendency to make very little, if any contribution to the depreciation and obsolescense funds with the result that money has to be borrowed for every little extension, whereas ordinary prudent business demands that such extensions should be met from current revenue.

(2) When charges for electricity are higher than necessary it becomes more difficult for the Undertaking to meet competition from other sources of power, such as gas, coal, paraffin, etc., and the progress of the Undertaking is therefore retarded.

(3) The legislation adopted in England is evidence that the principle of contributing to the relief of rates has been abused and there is ample evidence that abuse is taking place in this country.

(4) In cases of such Trading Undertakings as Abattoirs, Waterworks etc., many Councils have deliberately adopted the policy of not taking any profits, if any, for the relief of rates, and if the policy is sound in such cases, why is it not sound in the case of electricity?

(5) The fact that Councils can transfer large balances from Electricity Undertakings to meet expenditure on what are often "wild cat" schemes leads to extravagance for which ratepayers must ultimately pay either in extra rates or through the electricity tariff.

(6) The fact that the Electricity Act definitely took the supply of electricity out of the hands of private enterprise is an admission that, even in a capitalistic State, electricity supply must be regarded as a public utility and that it is essential to modern civilised life and should therefore be supplied at the lowest possible cost.

(7) A large domestic consumer of electricity is taxed twice, first as a property owner, and secondly as an electricity consumer, whereas the person who uses no electricity at all is taxed once only.

These arguments for and against the policy of relief of rates from electricity surpluses have in the majority of cases been dealt with very fully and ably by Councillor James, and if we take a reasonable view of them I think it must be conceded that there is quite a lot of truth and sense on both sides. If we admit this then it follows that we should endeavour to steer a middle course between the wholesale adoption of the policy and its total abolition.

I do not think that we as engineers desire to deprive our Councils of the whole of our surpluses, but merely to restrict the amount taken for the relief of rates to a reasonable figure which, while proving adequate compensation for the various services that are beneficial to our Undertakings, would at the same time permit us to build up a Reserve Fund and reduce our tariffs to an extent which will make them more in accordance with Costs.

If, for example, our Councils would permit us to contribute to a Reserve Fund and to restrict the amount applied in relief of rates in any one year, to say 2 per cent out of the outstanding debt of the Undertaking, then I feel we would have achieved a great deal, and in the course of time our Undertakings would be in a much better financial position than they are to-day. The councils, on the other hand, would be able to budget for a definite contribution from their Electricity Undertakings. In conclusion, may I again thank Councillor James for his excellent contribution to this question (Applause).

Mr. Muller (Krugersdorp) : I would like to thank Councillor James for his truly excellent paper. In regard to this question there are the

usual two sides, namely, the Councils and the engineers. In the first instance many Councils, especially on the Rand, have been forced into heavy non-productive expenditure as the result of exceptional expansion and the public demand for certain services. To finance these they look to the trading departments whose profit has also increased with this expansion and the development of the towns. If these profits were not available to them the rates would necessarily have to be increased, which might possibly be detrimental to the further development of the town by scaring off new business and new residents.

The engineer is fully aware of this point of view, but feels that the practice is very much overdone. He does not wish to live on the charity of the ratepayers; on the other hand he does not care to pose as a charitable institution. No engineer should object to pay a fair rate as an ordinary business undertaking, or at any rate some fair and fixed amount, leaving him at least the hope that any profit in excess of this amount could be used for the betterment of his Undertaking either in the form of a reduction in the tariff or the establishment of a Reserve or Equalisising Fund, or even Repayment of Loans.

Such a procedure would at least give the engineer something to work for, which in itself is worth something to the Undertaking, apart from any direct advantages which might accrue. (App).

Councillor Hofmeyr (Stellenbosch) : Whilst I heartily endorse the congratulations extended to Councillor James by previous speakers, for the strong and well-reasoned case he put up, I would, nevertheless, qualify my endorsement and make it quite clear that to my mind the arguments advanced, although perfectly sound when applied to the bigger Municipalities definitely do not hold water in all cases, particularly in respect of a town like Stellenbosch.

It seems to me that the three main points relied on in the paper under discussion by Mr. Councillor James, which must weigh very heavily with every Municipality, are as follows :—

(1) Provide for obsolesence, replacements, etc.

(2) There should be no overcharge for current in order to meet competition.

(3) The price of current should be as reasonable as possible in order to attract industries

I shall now endeavour to show that these main points, particularly in the case of Stellenbosch, are definitely not applicable.

(1) In Stellenbosch, and of course my arguments in regard to Stellenbosch are applicable to every similar Municipality, we are not burdened with a generating plant as we obtain our supply from the Electricity Supply Commission. In our case, therefore, though we naturally must make provision for improved distribution as the demand arises, obsolesence as such, is virtually a negligible consideration, no heavy capital being invested in machinery and plant as is the case with Municipalities generating their own current.

(2) Again one could quite appreciate that in bigger Municipalities where other means of heating and lighting is available, as for instance gas, the question of competition is a serious one but in Municipalities, remote from thickly populated areas, this competition does not exist, nor is it likely to arise for very many years to come, so no fear need be entertained on this score.

(3) The attraction of industrial undertakings is of course undoubtedly a matter which receives the very serious consideration of every live Municipality and the charges for electrical current plays, without a doubt, an important part, all other things being equal, when an Industrial Undertaking has to decide between the one city as against another, for the election of its sphere of activities. Here again, however, all other things are never equal. Com-

pared with its more fortunate neighbours, Stellenbosch, for instance, suffers the severe handicap of not being on the main Railway line. The question of attracting industries has had serious consideration at Municipal Congresses and if my memory serves me correctly, the Government has actually been approached with the object of bringing about a more even distribution of industries. I think it was suggested, that by way of subsidy or otherwise, the Government should make good the lack of geographical and other facilities of the less favoured Municipalities. In any event, we in Stellenbosch, in terms of our regulations, which provide that industrial power can be charged for by way of contract with the Council, leave the door wide open for the utmost encouragement to attract industrial undertakings because by such contract the lowest possible charge for current could be arranged. Stellenbosch, despite the most attractive features in other respects, is unable to induce the establishment of industrial undertakings within its borders solely because of its situation on a loop line instead of on the main railway artery.

Apart from industries the next best source of revenue and improvement which a Council, to my mind, should consider, is building progress. In this connection of course the most obvious and important consideration is the Rate levy.

Is it therefore unfair, unethical or illogical to keep the Rate levy in a Municipality like Stellenbosch at as low a figure as possible particularly, when, as I maintain, this is virtually the only possible means of advancement of a Municipality like ours, situated as it is, less favourably than our immediate neighbours? Can we, therefore, be adversely critized, if, under these circumstances, we utilise the proceeds of our electrical charges for rate relief ?

Against this latter argument I am quite prepared to admit some very telling points can be made, particularly on moral grounds, but even

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then it is my considered opinion that the pros far outweigh the cons. Here I will heartily endorse the statements expressed by Councillor Smit of Bloemfontein, who maintains that if you reduce your charges for electricity to the extent of being unable to obtain rate relief from this source, the Municipal rates on buildings would be increased and this will have the effect of largely retarding building operations and thus prevent expansion in the only remaining way.

Apart from the aforegoing there is this important consideration that Municipalities like Stellenbosch and Grahamstown, where the valuation of non-rateable properties are abnormally high, are afforded, through the medium of their electrical charges, at least a means of ensuring a more equitable distribution of the financial burden of a Municipality upon its ratepayers.

Councillor Capell (Durban) : I feel that I must support the present policy of the Durban City Council of taking from the Electricity Undertaking the profit it is making and applying it to the relief of rates.

We in Durban do all the things that have been condemned; we take money as a direct contribution to the rates, we make the fullest charges against the department, but despite all that we in Durban supply what is perhaps the cheapest current in South Africa ('No, no!') for domestic consumption it is the cheapest in the Union ('No, no!')

It all comes back to the position that the Council is responsible to the ratepayers. The ratepayers are the people who supply the finances of the borough as a whole, and those assets are pledged to provide loans for the Electricity Undertaking and to make good any other Undertakings that make a loss. Hence if any of these Undertakings make a profit it is entiled to make a contribution to the relief of rates.

It has been said that the law provides that there shall be no profits for the relief of rates, but that any profits shall be used in the direction of reducing the tariff to the consumers.

We have had that experiment tried on us by the Provincial Council in connection with the local Abattoirs, and we have found that the charges have remained the same, despite the attitude of the Provincial Council, and there has been no reduction in the charges made to the farmers.

You will find that if you are prevented from making a contribution for the relief of rates Councillors will find other means of taxing the Electricity Undertaking.

We have in this city a Transport Undertaking which for many years provided a useful contribution to the rates, in exactly the same way as the Electricity Undertaking has done, and the engineers have protested against the profits of these Undertakings being used for the relief of rates.

We do not know what is going to happen in a few years' time. It may then happen that the Electricity Undertaking will have to be subsidised from the Borough Fund, in the same way as has happened in regard to the Transport department.

There is one other point mentioned by Mr. James that I would like to touch on—that of industries that are beyond the confines of a particular Municipality. These people go outside the Municipality because it is economically more profitable to do so, and they purchase electric energy for that very reason. They do not provide any of the Capital necessary for the Undertaking; they are birds of passage.

It may be that in time they will provide their own electric power and cease taking energy from the Municipality, therefore it is only reasonable that these consumers should be called upon to

pay a tariff somewhat higher than that charged to the ordinary consumers in the borough, who are the citizens responsible for the concern. I feel that the Councils are entitled to some consideration in this matter.

Perhaps it is rather different from the point of view of the engineer, but it is the Councillors who are directly responsible to the citizens, who do not, as a whole, appreciate direct taxation. (Hear, hear.)

While you have this method of indirect taxation, which is successful and which, I think, is rather thinly disguised, (laughter) I think Councillors are entitled to take advantage of it to the fullest possible extent while an Undertaking is making a profit, because at a later stage, as we have found in Durban, you have to make up the losses incurred by any other concern. (Applause).

Mr. Swingler (Cape Town) : One of the difficulties, and perhaps the greatest one, which those meet with who desire to see the principle of rate relief dealt with strictly on its merits, is that of lack of appreciation on the part of the general public of the way in which excessive rate relief affects their pockets. The general public indeed, as a whole, is usually quite unaware of what the effect of direct and indirect taxation of this nature has in this direction, and more often than not will, through inappreciation of the fact that they are the persons who actually pay the tax, applaud a proposal involving the making of such taxation in the fond belief that someone else will pay. Propositions that, for example, money should be provided for certain purposes by the Government or the Municipality or some other body rendering a public service, are popular largely because it has not occurred to those who vote for them that in point of fact they are merely voting for taking money from one pocket to put into another with the certainty of losing some in the process. Few, if any, who are not intimately concerned in the

proposals understand that actions of this nature may bring about an increase in the rates of charge for the service which they receive or will prevent a decrease which might have been made possible had such proposals not been given effect to.

It is quite outside the scope of the duties of officials to inform Electricity consumers on this aspect of the matter, and the most than can be done to protect consumers from the results of their own inappreciation of the state of affairs is to obtain the assistance of legislative bodies controlling the Municipalities and a resolution to that end should be adopted by our Association.

In his paper Mr. James has drawn attention particularly to the need for ensuring that no contributions be made to the relief of general rates at the expense of the financial stability of the Undertaking, and in doing so he has stressed the possibility that a surplus may be shown from which such rate relief may be made which is in fact obtainable only from inadequate provision being made for depreciation and obsolescence. Inadequate provision under these headings might quite well be made unwittingly by those responsible for the successful operation of the Undertaking, and in this connection I would recommend for the careful consideration of members of our Association an article by the City Treasurer, Pretoria, which appeared in the April, 1937, edition of "The South African Treasurer," in which he draws attention to the following essential points to be borne in mind in deciding upon the extent of the obsolescence reserve which he recommends be built up in every public utility :

"(1) There must be close co-operation and consultation between the Financial Officer, the Auditor, and the Engineer, the Financial Officer having the final decision.

(2) Careful thought must be given to the general state of affairs of each undertaking—its financial history, the degree of wear and tear, the trend of develop-

ment of similar undertakings and the internal and external influences that may be at work to render the undertaking ultimately obsolescent.

(3) Cognisance must be taken of Sinking Fund provisions and loan repayments.

(4) The probable future extra earning or reduced earning capacity of the undertaking and its general financial condition.

Set out thus, the task perhaps appears formidable, but if the right spirit of co-operation is exhibited by the officers concerned and reasonable care is exercised, there should be no real difficulty in maintaining the financial stability of any undertaking and strengthening it so that it will be able to meet any extraordinary financial strain."

That some undertakings do not give full consideration to this aspect of the position and are prepared to use various expedients to meet the financial exigencies of the moment is illustrated by the following. One of the larger Municipal Undertakings in the Union of South Africa shows an accumulated deficit at the end of each of the undermentioned years as shown from £12,598 to £18,756 with contributions to rates ranging from £25,000 to £34,000.

Year :	Accumulated Deficit at end of year :	Contributions to Rates :
1932	£12,598	
1933	£22,580	£25,000
1934	£19,280	£25,000
1935	£1,708	£25,000
1936	£9,307	£34,000
1937 estimated	£18,756	£34,000

The balance in the reserve fund at the end of 1936 was approximately £7,000 and there was a balance of £9,000 in the renewals and obsolescence fund for the same time. The total capital expen-

diture on the Undertaking is approximately £1,200,000 and the ratio of loan indebtedness to capital outlay is 65.6%. What the latter figure will be when the projected large capital expenditure is incurred in the near future, I can leave to the imagination of our members, but it is certain to be so great that the sound financial position of the Undertaking is more than questionable. A special point of interest in this Undertaking is that the amount set aside to renewals (depreciation) during the year 1936 was only £7,531 as compared with £34,000 contributed to the relief of rates.

In another South African undertaking with a capital outlay of approximately £400,000 for land, buildings, plant and equipment, the amount set aside during the year ending 31st July, 1935, for depreciation was but £6,740, whilst £12,059 was relegated to the relief of rates.

A most important point which is often lost sight of is that where, as in the past and may be in the future in South African electricity supply Undertakings, the periods of the loans from which the assets of the Electricity Undertakings have been purchased exceed by **a long period** the **useful life of the plant,** payment to the sinking fund only represents insufficient provision for depreciation and obsolescence resulting in a fictitious surplus and to contributions to the relief of general rates whereby it is necessary to raise loans for the replacement of plant when it becomes obsolescent, is in fact raising loans for the relief of rates. The unwisdom of not making adequate provision of this nature has only to be seen in that light to be fully appreciated. This aspect of the financing of Undertakings should also be brought to the notice of the Provincial authorities with a view to the period of the loan being fixed on the life of the asset.

The following extracts from a Paper submitted by W. E. Foden, A.S.A A., formely Financial Controller, Electricity Department, Manchester, to

the Institute of Municipal Treasurers and Accountants (Great Britain) on the 17th June, 1937, is also of great interest in this matter.

"BALANCE SHEET TECHNIQUE

While on the twin tops of debt redemption and capital outlays, the author would urge that all the influence of the Institute should be given to the policy of deleting from the Capital Account all outlays on sold, abandoned, or discarded assets, by a corresponding amount written-off the so-called sinking fund surplus. This is known to be the desire of the Electricity Commissioners and has always been the practice in Manchester; the author was indebted many years ago to the teaching in this connection of this year's President of the Institute of Chartered Accountants, who then showed the weakness of the double account system.

An example of the need of consistant annual writing-off was strikingly revealed not long ago, when one of the largest municipal electricity undertakings, which had neglected it, was compelled by force of events to write off in one full swoop about £2,250,000, and to reduce the artificial sinking fund surplus correspondingly. Obviously electricity capital accounts should be confined to existing assets and the contra item in the balance sheet, dealing with sinking fund surplus, should be correlated to existing assets only. The Institute has, in fact, agreed with the Income Tax Commissioners, after consultation with the Electricity Commissioners, that aggregate capital expenditure shall be exclusive of expenditure on discarded assets.

RATE AID :

The author notes with pleasure the fall in rate aid from £742,031 in 1925-26 to £566,208 in 1935-36, because, though long a believer in moderate rate aid, within the limits allowed by the 1926 Act, he has come round to the view that the best services municipal electricity supply can render are to sell as near to cost as is reasonably safe to attract rateable value by the supply, and to hasten the day when electricity consumers and ratepayers are practically the same body.

Moreover, when the McGowan proposals are implemented and merger of small with large municipal electricity undertakings occurs, rate aid will become very difficult, it not impracticable. Commenting on the present position, however, it may be said that the requirements of the 1926 Act regarding investment of reserves in statutory securities as a pre-condition of rate aid seem to have been ignored by some local authorities, and the policy of using reserves for capital expenditure and other purposes seems unsound financially, apart from the legal aspect. Used in this fashion, of course, the reserves cease to be reserves." (Applause).

Mr. Behrens (Port Elizabeth) : I want to add my appreciation of the excellent paper submitted by Councillor James. With most Undertakings the trouble is that loans are for too long a period, and insufficient provision is made for building up a Renewals Fund.

The plant often comes to the end of its economic life before it is paid for, and monies are taken for the relief of rates before making this provision. Generally the large consumer does not benefit by the relief of rates.

As an example the local gas company, which is in competition, has its rates reduced but does not consume any electricity. We contribute £34,000 to the relief of rates, which is equivalent to .645d. per pound or .17d. per unit sold. Take the case of two consumers, A and B :—

	A.	B.
Value of property	£1,260 0 0	£3,545 0 0
Rate of 4½d. in the £	£23 12 6	£66 4 5
Units consumed	5,295	2,080
Cost of current	£17 12 0	£15 12 5
Saving in rates due to contribution	£3 8 0	£9 10 0
Saving in current if reduced .17d. per unit	£3 15 0	£1 9 0

From the above it will be seen that a consumer using only benefits by the rates contribution to a greater extent than a larger consumer who goes in for cooking, etc. The same applies to industrial users as shown in the cases below, X and Y being factories and Z being a large institution in the town :—

	X.	Y.	Z.
Value of property	£20,370	£71,050	£46,810
Rates at 4d¼.	£382	£1,331	£878
Units consumed	442,323	761,052	345,458
Cost of current used	£1,408	£2,140	£1,483
Saving in rates due to contribution	£55	£192	£126
Saving in current if no contribution was made but price per unit reduced by :17d.	£270	£539	£244

(Applause).

Mr. Milton (Electricity Supply Commission) : I have endeavoured to refrain from entering into the discussion on this vexed question of relief of rates. It is, however, one of the problems which face the Commission when performing its duties under Section 38 of the Electricity Act which virtually places the Commission in the position of adviser to the Administrators in respect of Municipal Electricity Undertakings throughout the Union. It has been my lot during the last six or seven years to deal with every projected Municipal Electricity Undertaking, and the extensions of existing Undertakings. This work has necessarily placed me in touch with a vast amount of very confidential information, and makes it very difficult for me to point any remark with fact, as at all times I must be careful not to divulge information which is of a confidential nature.

Mr. Councillor James is to be congratulated on a very excellent and concise exposition of the problem before you. So far, however, the dis-

cussion tends to lead one into the erroneous view that the present debate is between Councillor members and engineer members in opposite camps. The error is really obvious, as it is a Councillor member who has actually put forward what is frequently described as "the engineers' case." Both the engineer and the Councillor should be on common ground, as both are dealing with a problem the solution of which, to be sound, must be in the interests of Municipalities as a whole, and not one section thereof. Viewed from this aspect much of the usual bitterness accompanying discussion of this subject should fall away. We have heard Councillors state that they must consider the ratepayers, and the inference to be deduced is that engineers have no consideration for the ratepayers. Such innuendoes are to be regretted. (Hear, hear).

We have heard it said that the general plea for the abolition of 'relief of rates' is that it is merely taking away with the one hand to give with the other, and a case was quoted of a hypothetical community established on Robben Island, where it was assumed that a Scholastic Institution desired to establish premises and take a supply of electricity from a profitable Electricity Undertaking. It was pointed out that if the profits were not used for the relief of rates the Scholastic Institution would certainly receive its electricity at a lower rate, but would be faced with a compensating greater charge in respect of direct rates.

This example shows that the "taking away with the one hand and the giving with the other" was actually taking place at the time the Scholastic Institution was assumed to have applied for a supply of electricity for premises it desired to establish, and the previous speaker has, therefore, presented us with the anomaly of an example supposedly in support of the relief of rates which, when analysed, actually supports the reverse procedure.

If the amounts taken for the relief of rates from electricity surpluses had the effect of exactly compensating amounts from the individual ratepayers and/or rents-payers, then one would be arguing merely for a matter of principle, but Mr. Behrens, of Port Elizabeth, has quoted actual figures which show that the surplus accrues from individual consumers in a proportion which is in no way related to rateable value of premises, and these figures should prove conclusively the unfair distribution of costs in relation to non-revenue producing Municipal services, which are supposedly proportioned on a rateable value basis.

A suggestion has been made that a committee be appointed to investigate the problem and report back. Such a committee might investigate the relation between the incidence of reduced tariffs and increased rates to offset previous relief. To take individual selected cases may be misleading, and it would seem to be desirable that the investigation should cover every consumer individually for a few large, medium, and small Undertakings selected as being typical of their size. The committee's report could then be relied on to reflect the 'majority' position and not the doubtful position of 'the few.' I can express the opinion, based on actual knowledge gained when considering Municipal schemes, that Municipalities are often perturbed about problems of additional loan capital when really there should be no necessity for concern.

You would be surprised at the number of instances where Municipalities have, over a period of years, made very substantial surpluses, which have been allocated to relief of rates without a record being kept of the accumulated sum so diverted, and where such Municipalities have been faced with very heavy capital expenditure involving serious loan commitments on Electricity account, the capital charges on which have been likely to involve annual deficits on the Undertaking over a period of a few years. Had these

Municipalities established accumulated surpluses these could have been called upon in times of need to finance actual deficits, and the Municipalities and Administrators could have faced the solution of the problems with absolute equanimity. I am not arguing that these accumulated surpluses should not be used to finance capital works of Municipal departments other than the Electricity department. Surpluses so diverted could be regarded as temporary loans on very favourable terms, provided it is established and recognised that the sums of money so lent are not lost for all time to the Electricity Department.

It is quite usual to find that the Loan terms on which a Municipality is able to borrow money are less favourable than its re-investment rates, and this fact should certainly be turned to the advantage of the Municipality whenever possible. On the other hand there may be justification for some contribution towards relief of rates provided, however, that there is a maximum limitation imposed on such contributions as it seems to me to be only reasonable that each Municipal department should not be regarded as completely divorced from all other departments. After all, each department should have at heart the interests of all other departments, and should have every regard for the requirements and difficulties of each other department.

Loan periods have been questioned, and an impression has been created that loans should only be raised for the period of the life of the assets to be purchased therefrom. Engineering is always a matter of applied economics, and is not merely a matter of application of scientific formulæ to practice without regard to costs, although this is seldom realised by non-technical people. From this point of view, therefore, the engineer must always consider the financial aspect of his problem in conjunction with the technical aspect in order to arrive at the most satisfactory solution—a very difficult task, as this demands that he be

no mean prophet ! Loans must be raised for periods which will produce the most satisfactory overall financial position, and therefor must be on terms such that the Interest and Redemption rates coupled with the concurrent Depreciation or Reserve rate must, in total, provide the lowest annual cost to the Municipality. If it is possible to raise forty, or even sixty-year loans which will produce this advantage, there is no reason why they should not be raised, provided the estimated Reserves are actually established and maintained. After loans are raised, however, the engineer is often lost sight of and others object to relatively large sums being set aside to Reserve, even though Loan periods may be vastly in excess of the life of the assets purchased. When the Reserves are not properly established the time ultimately arrives when the poor Electricity Undertaking is accused of being a liability instead of an asset, which is most unfair.

So far I have dealt with the problem on the assumption that profits have been made. If loses are incurred, however, I realise that 'General Fund' is called upon to finance the working costs of the Electricity Undertaking. The contra argument to the above, therefore, applies and these losses should show as a total accumulated deficit over the period, the Electricity Department being required to reimburse General Fund in full before it can accumulate reserves.

Reference has been made to the objections which will be raised by ratepayers to an increase in the rates, although this is accompanied by equivalent overall reductions in the electricity tariffs. If the ratepayers object, as it is an objection expressed by a body of people which, in general, is entirely ignorant of the facts surrounding the case. We have been told that Councillors represent this body. If Councillors were willing to educate their public to a full knowledge of the true facts of the case, I feel satisfied in my own mind that most of the expected outcry would never be heard.

Just as it is the duty of the engineer to find the true economic solution, so it is the Councillors' duty to support that solution even though it demands that the public be educated to understand the reasons for the decision taken. In conclusion I feel sure that if the problem is studied in the light of Councillor James' paper, and the discussions thereon, a very satisfactory solution will be reached. (Applause).

Dr. Dobson (Johannesburg) : I wish to join the other speakers to congratulate Councillor James for his paper, and I feel sure it is highly appreciated by all Councillor members and Electrical Engineer members at this Conference. In making my remarks, I propose for the sake of clarity, to divide the subject into separate and distinct sections so that the real meaning of surplus profits will be clearly understood.

Loan monies for Municipal Electricity Undertakings should be for periods of years which correspond approximately to the "lives" of the plant for which the capital is provided — this would ensure that when large capital has been expended, it is adequately "written off," and the absurd position would never arise that "Interest" and "Redemption" charges are continued for many years over the long unexpired portion of long period loans **after** the plant has in reality ceased to exist. In addition to the Interest and Redemption charges, adequate Reserve Funds should be provided for Renewals, Obsolescence and Betterment so as to meet circumstances as do arise in Municipal Electricity Undertakings as a result of unforseen rapid growth of demand resulting in plant originally installed becoming unsuitable for the consequent unexpected increased loads, or alternatively may become obsolete due to engineering improvement resulting in much greater efficiency and more economical working. If Capital charges of this description are not provided for on such sound basic principles, it must be obvious that "nett surplus profits' 'are fictitious and mis-

leading, and the "day of reckoning" for such unwisdom will come sooner or later. In this respect, Mr. Swingler has referred very appropriately to the varying positions as they exist in several of the S.A. Municipal Electricity Undertakings.

I am very strongly of the opinion that some uniform system of dealing with Loans commensurate with the "lives" of the plant involved; and the uniform provision of adequate Reserve Funds should be made applicable to all S.A. Municipal Electricity Undertakings—I cannot foresee that any body of Councillors or Ratepayers would possibly raise any objection to such sound financial procedure. Terms of reference of the above nature should be referred to some competent Authority so that properly standardised procedure should be adopted by every Municipal Council in South Africa, and in future nett surplus profits would be real and genuine with all legitimate Capital charges debited to expenditure.

Let us assume that after all the foregoing charges have been made, the appropriation of the nett surplus profits have to be considered. Firstly, if the nett surplus profits be relatively small in relation to the "outstanding debt" of the Undertaking, comment is hardly necessary. Secondly, if the "nett surplus" is relatively large in relation to the outstanding debt, such circumstances would conduce on the one hand to a consideration as to whether consumers of electricity are being fairly dealt with, and whether a reduction of the Electricity tariffs is justified; and on the other hand what appropriation of such nett profits is fair and reasonable to the ratepayers for relief of rates. (In dealing with the subject of nett surplus profits, Municipal Electricity Undertakings should be paid for all services rendered to their Municipal Departments, on an actual full "cost basis" or cost plus a percentage—this principle should be uniformly applied to all Municipal Departments).

I am of the opinion that ratepayers are entitled to receive a reasonable share of the "true nett surplus profits" for the relief of rates, but it should be limited to a reasonable maximum percentage of the nett outstanding debt of the Electricity Undertaking taken in conjunction with the principle that all services rendered by the Electricity Department must be paid for by all the Municipal Departments concerned. If these principles were adopted, Councillors, Ratepayers, Municipal Electrical Engineers and non-ratepayers could feel that the Electricity Department would be run on the basis of financial stability for the greatest good of the Municipal community as a whole.

Taking South Africa as a whole, it is the ratepayer that shoulders the greatest burden of Municipal expenditure far beyond the responsibility for the "Interest' 'on Municipal loans referred to by Councillor James—a special example of which can be cited by the "Special Rate" imposed in Johannesburg for road improvements and the ratepayer has little or no opportunity of passing this on to the non-ratepayer. It is the ratepayer that initiates all the development of our Cities and Towns, and thereby the non-ratepayer derives appreciable benefits in every direction, not the least of which is that he secures his supply of electricity very, very much cheaper than he would otherwise secure without the energies, the foresight and the business acumen of the ratepayer.

South Africa is relatively a very young country and many Municipal amenities have to be initiated right from the ground floor and to a much greater extent than in older and more evolved communities overseas. For this reason, when a maximum limit is being placed on "surplus profits" for relief of rates, this aspect of matters should be taken into consideration and relatively a somewhat higher limit applied.

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My remarks are summarised as follows :—

(1) Loan monies should be on periods comparable to the "lives" of the plant involved.

(2) Adequate Reserves should be provided for annually for Renewals, Obsolescence and Betterment.

(3) Electricity Departments should be paid for all Municipal services rendered on a cost basis, or cost plus percentage basis.

(4) Before appropriation of nett profits are made, fair consideration should be given to the reasonableness of the Electricity tariffs.

(5) Ratepayers are entitled to an appropriation of surplus profits for the responsibilities they undertake; but in fairness to the non-ratepayer consumers, a reasonable limit should be placed on what should be applied in relief of rates—this limit should be on a somewhat higher scale in South African than overseas countries, because of the greater pioneering development required in a young and relatively undeveloped country like South Africa.

(6) I think it would be a good idea if a Sub-Committee of the Association were appointed consisting of Councillor and Engineer members to examine and report upon their recommendations on the subject taking items 1, 2, 3, 4 and 5 above as a basis of their investigations." (Applause).

The President : We have had a most interesting discussion on a most interesting paper, and I would now like Councillor James to have an opportunity of replying.

Mr. Swingler (Capetown) : I would like to propose a resolution that we make representations with a view to the introducing of legislation on the lines of the Cape Provincial Ordinance. Personally I do not agree with all that Dr. Dobson had to say. Though we are a young country, we are ahead of many others, particularly in regard to electricity. I would like to know your decision, Mr. President.

Councillor Smit (Bloemfontein) : On a point of order. Constitutionally I think it would be wrong to allow this matter to go to a vote. The Municipality I represent has given me no mandate to support the important resolution moved by Mr. Swingler. A motion such as the one proposed should have been placed on the Agenda. While some of Bloemfontein's Councillors might be prepared to support the suggestion put forward by Dr. Dobson, there are others again who would not brook any interference. I accordingly feel that if we are to vote on the motion to-day it would not be constitutionally correct.

Mr. Swingler : I think a resolution might arise out of the discussion on a paper, and I would like the President's ruling.

Councillor Gray (Johannesburg) : In regard to the question of legislation I think the Convention should be careful.

The President : I would like to suggest that we adjourn this discussion until to-morrow.

Councillor Coetzee (Springs) : May I support that suggestion. I would like to say a few words in regard to the discussion that has taken place and to reply to Councillor James.

Agreed.

The Convention adjourned at 1 p.m.

WEDNESDAY, 10th November, 1937.

The Convention resumed at 10.10 a.m. in the Ball Room, Marine Hotel, the President in the Chair.

SUPPLY REGULATIONS.

The President : Gentlemen, a draft copy of the Supply Regulations has been submitted to the Council, and will be gazetted very shortly.

The Council decided unanimously that a vote be taken after the Regulations have been gazetted and circulated, and that if the majority are in favour they will be submitted to the members of the Association for adoption by their Undertakings as far as possible. I shall be glad to have your approval of that.

Agreed.

LICENSING OF ELECTRICIANS.

The President : In regard to the Licensing of Electricians, a Bill will be brought before the next session of Parliament, and it will be gazetted in due course.

GENERAL.

The President : With reference to the grading of the salaries of engineers, which has been discussed by the Council, the grading list in Great Britain has been obtained, and anyone requiring a copy may get one on application to the Secretary.

The Council has decided that at future Conventions only an outline of the various papers be given by their authors in order to permit of more time being available for discussion. (App). I shall be glad to receive from members offers of

papers for our next Convention at Capetown. We will now continue the discussion on Councillor James' paper.

DISCUSSION (continued) Councillor James' Paper.

Councillor Robbins (Pietermaritzburg) : May I be allowed to move that this question of contributions for the relief of rates be referred to a Sub-Committee to investigate and report. I move that motion because I feel it is not wise at the present moment to rush things.

I am a newcomer among you, but I have had a lot of experience as an Accountant, and as an Accountant the arguments put forward by Councillor James appeal to me very strongly.

I cannot help realising that it will be necessary for us to educate people in this matter (Hear, hear). Education is never done in a hurry, and I would rather this matter be examined by a Sub-Committee than rushing it and thrusting it down the necks of people who are probably half-convinced.

If you can convince a man you will win him to your side. You have convinced me, and I shall certainly give the proposal my support as chairman of our local committee. I know I have a hard battle to fight and a long row to hoe, but I feel that in this matter it is best to take time. (App).

Councillor Coetzee (Springs) : I have much pleasure in seconding that proposition, and in doing so may I express my thanks to Councillor James for his very interesting paper, and also to Dr. Dobson for his forceful address. I would like to say that there are Councillors who are prepared to face the public on a question such as this.

It is difficult to educate people to the point of making them fully realise and appreciate the importance of financial undertakings, and if the question is put to them in an intelligent form we

usually find that people realise that they are going to get a square deal and that provided it is tackled in the right way the difficulties can be overcome. Personally I have learned a great deal from this discussion that will be a very great assistance to me as a member of the Springs Municipality. (Applause).

The President : If there is no further discussion, the motion has been moved and seconded.

Agreed.

The President : Now comes the question of the constitution of the Sub-Committee. Perhaps Councillor Robbins has a suggestion in that regard.

Councillor Robbins (Pietermaritzburg) : I do not feel that I am in a position to do so. I merely wanted to get the principle adopted.

Mr. Rodwell (Johannesburg) : I suggest that it be left to the Council to nominate the Sub-Committee for this important matter.

Agreed.

Mr. Swingler (Capetown) : On a matter of this kind I certainly think the Sub-Committee should report back to the next Convention and be again considered by the main body of members. It is not advisable to rush it.

Councillor Hofmeyr (Stellenbosch) : I will second that.

The President : Is it agreed that the Sub-Committee report back to our next Convention ?

Agreed.

The President : I now call upon Councillor James to reply to the discussion on his paper.

REPLY by Councillor W. James.

Mr. President and gentlemen, my thanks are due to those members of the Convention who have spoken on this subject. Perhaps I am a little disappointed that more Councillor members did not participate in the discussion, but I am deeply grateful to Councillor Capell for the assistance he gave me yesterday, when he pointed out that one of their Durban Undertakings was in such a state through neglect to provide funds for Obsolescence that it was necessary to subsidise it from the rates. That fact should be impressed upon the minds of every Councillor member present, so that when he returns back home he will investigate and see that none of their Undertakings are placed in a similar unsatisfactory position. (Hear, hear).

In regard to what was said by Councillor Hofmeyr, who I believe is the chairman of the Finance Committee of the Stellenbosch Council a district which, I believe, has recently had a valuation of over a million pounds I am rather afraid he is casting his eyes upon the profits of the Electricity Undertaking. He mentioned yesterday that the only way in which they could expect growth and expansion was by the building of houses. Now those who know anything about property know that the first thing a prospective resident wants to know is what amenities a town possesses, what its surroundings are like, and what is the cost of its services.

In view of what is being paid for domestic power and light at Stellenbosch, I think it is about time that they investigated the position with a view to seeing whether some of the profits should not be returned to the consumers.

I have often been to Stellenbosch, and I have seen evidences there of one of the oldest industries in the country, namely the wood industry. It is about time they set about reducing their tariff so

that this old industry shall not be carried on as in the days of the ox-wagon any longer than necessary.

I would also like to commend to Mr. Hofmeyr the remark of his fellow Councillor from Springs who said that if you are prepared to put the whole facts before the ratepayers they will use their intelligence sufficiently to be able to appreciate your point of view. In this connection I want to warn you not to camouflage your expenditure. You may get away with it for a little while, but it will eventually be found out, and then you are for it. (Hear, hear).

The wise Councillor takes the advice of his highly paid officials, who have had many years of experience, and who have the interests of the community at heart. Any Councillor who ignores the advice of his technical experts is looking for trouble.

I much appreciate the comments of my Councillor friend from Maritzburg and readily accept his suggestions. This matter will take time, and we would rather wait another five years and achieve our object than let it be said that we attempted to steam-roller the thing through. I have to thank you all for the very patient hearing you have given me, and for the way in which you received my paper. (Applause).

The President : I will now call upon Mr. Penny to give us his paper on "The progress and development of the Natal Central Undertaking of the Electricity Supply Commission."

Progress and Development in the Natal Central Undertaking of the Electricity Supply Commission.

With Special reference to the past Ten years.

by N. D. Penney.
of the Natal Central Undertaking.

The progress experienced during the past ten years represents a very successful effort, equally shared by both the Natal Central Undertaking of the Electricity Supply Commission, and the many consumers connected to the Undertaking. This progress as far as the Commission is concerned consists of a comparatively large series of extensions over and above the area originally covered, whilst for the consumer it consists of a relatively substantial decrease in the cost of current purchased; together with considerable expansion.

It is generally well-known that in 1927 the Natal Central Undertaking was created as a result of the Electricity Supply Commission taking over from the South African Railways & Harbours the 60,000 k.W. power station at Colenso, with its attendant 88,000 Volt transmission line system established between Pietermaritzburg and Glencoe, together with the twelve traction substations situated along the route.

Previous to this change in ownership the Commission had been negotiating with several Municipalities with a view to providing each with

bulk supply of current. At the time of the transfer, a partial supply was being given to the City of Pietermaritzburg, whilst the Municipalities of Estcourt, Ladysmith and Glencoe had already become consumers.

In 1929 the first extension to main line traction was undertaken, the section between Pietermaritzburg and Cato Ridge being converted from steam to electric haulage. Although the conversion of this comparatively short section did not appear to the public as being of any considerable importance, it was in reality the birth of a truly economic form of construction which has withstood the test of time and justified the faith placed in it by the Railway Administration.

The economies effected consisted in the application of otherwise useless rail metals to structure purposes, and the discarding of the mass for neatly designed stress foundations. Further reductions in expenditure have since been introduced on the newer extensions by the adoption of electric welding. The Railway Administration engineers are to be sincerely congratulated for their achievement in this respect.

The Commission has, on its part, not only fully subscribed to economic electrification by the adoption of mercury arc converters, but has largely contributed to the furtherance of this new type of converter by requiring it to be capable of running inverted.

The conditions of supply which the "Undertaking" is, to-day, required to meet, vary from the demand of our largest consumer, i.e. the South African Railways & Harbours, right down to the small country cottage. Thus, whilst the monthly account rendered to the one would be for millions of units, that to the other would be for a few units only used perhaps to light two or three rooms. Between these two classes of consumers we have a third type, referred to in our records

as "Bulk Supply Consumers." Included in this group are several of the Municipalities and Industrial concerns where consumption is sufficiently large enough to warrant the purchase of electricity at the published tariff rates. Thus we have three main types of supply to consumers—Traction, Bulk, and Small Power Users and Domestic Supplies.

S.A. R. & H. TRACTION SUPPLIES :

To-day, the whole of the main line from Durban to Volksrust, and the line from Ladysmith to Harrismith in the Orange Free State, is supplied with direct current energy at a pressure of 3,000 volts.

The converting apparatus for supplying the direct current to this stretch of about 380 miles of electrified track includes twenty-three motor generator sets, each with a capacity of 2,000 k.W., twenty rectifiers whose individual capacity is 1,660 k.W. and nine rectifiers, each with a capacity of 1,500 k.W.

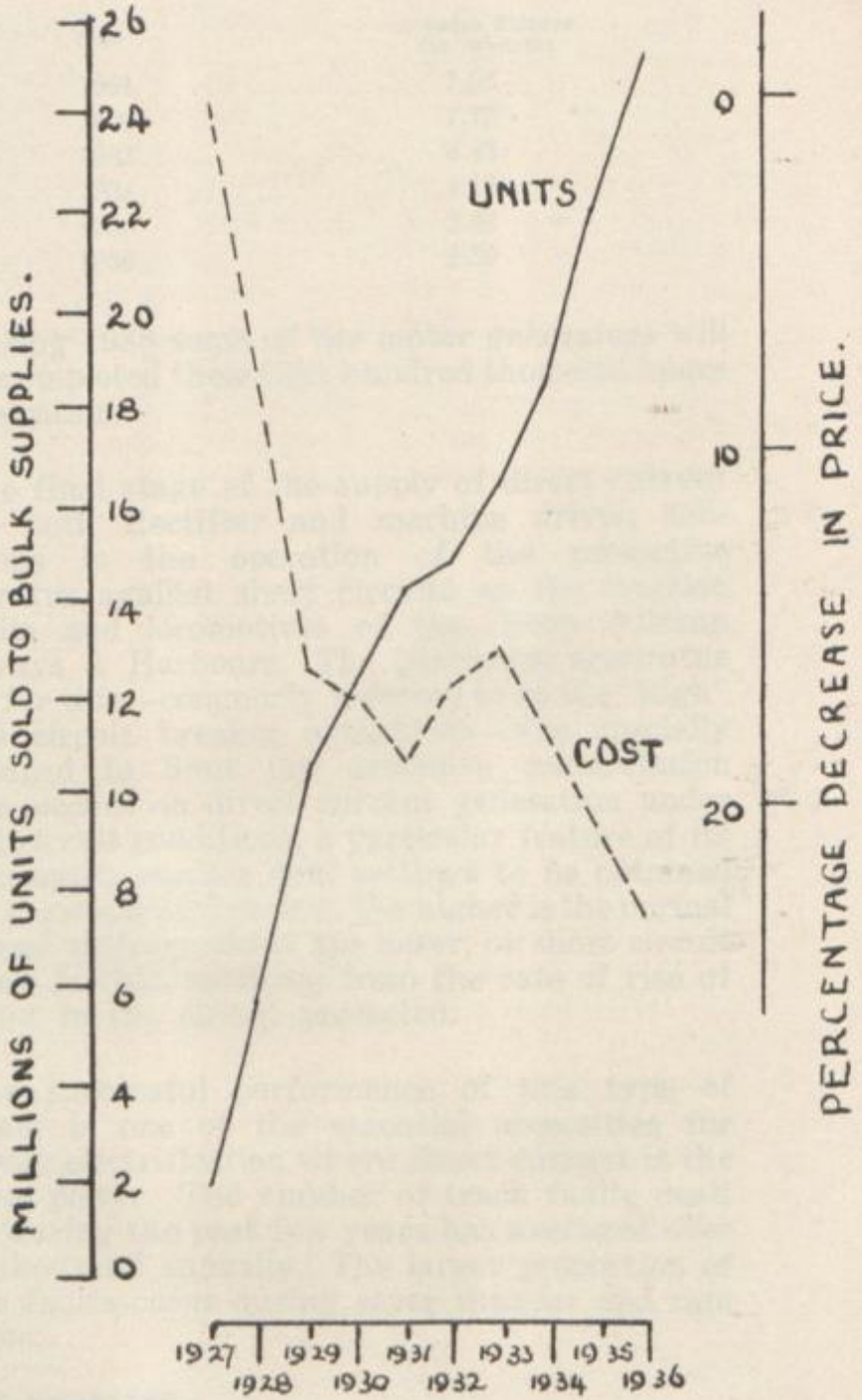
The whole of the above plant is located in twenty-six sub-stations distributed along the route. With the exception of the plant at three substations situated at points on the railway where the track is comparatively level, all converting apparatus is of the regenerative type.

The principles adopted by the manufacturers of the mercury arc converters for introducing regeneration into this class of machinery, consists of the use of two rectifier units, both of identical design, but linked to different secondary windings on the common transformer. The cathode of the converter linked up as a "rectifier" is naturally connected to the positive circuit, whilst that of the "inverter" is connected to the negative circuit. The neutral points of the two six phase secondary windings are linked to the negative and positive circuits respectively. It is thus possible to link up either converter as a rectifier or inverter as may be required.

The use of electrically charged grids enables the firing of the anodes to be brought under complete control both as regards timing and selectivity, whilst use is also made of the various changes in loading to control the compounding. The above combination taken in conjunction with the usual protective and ancilliary apparatus, results in a unit capable of delivering and receiving direct current energy under conditions of main line traction. The curve below (Fig. 1.) is a copy from the recording ampere meter chart, taken from one of the substations on the main line south of Cato Ridge. It indicates that there is no practical difference in performance between the modern regenerative mercury arc converter and the very fine motor generator equipment, which in the past has served all traction requirements so effectively.

(Fig. 1)

With the advent of the mercury arc rectifier, one is sometimes inclined to lose sight of the present satisfactory performance of motor generator equipment. This class of machinery has given satisfactory operation for a considerable number of years, but like all modern engineering products, the performance depends upon a maintenance worthy of its design. On the Natal Central Undertaking very detailed records of each portion of the equipment are kept, each device is enumerated and every failure—however small—is entered up. Thus we are in a position to watch the performance of any particular phase in the operation, or any device in the equipment, from year to year. Most of the failures, mentioned above, occur on the many devices of which there are about one hundred including fuses, controlling the automatic equipment of each machine, and it may be of interest to review the average number of failures which have been experienced during the last six years on the automatic equipment apparatus.



REDUCTION IN PRICE TO BULK CONSUMERS WITH INCREASE IN CONSUMPTION AND LOAD FACTOR.

FIG 2

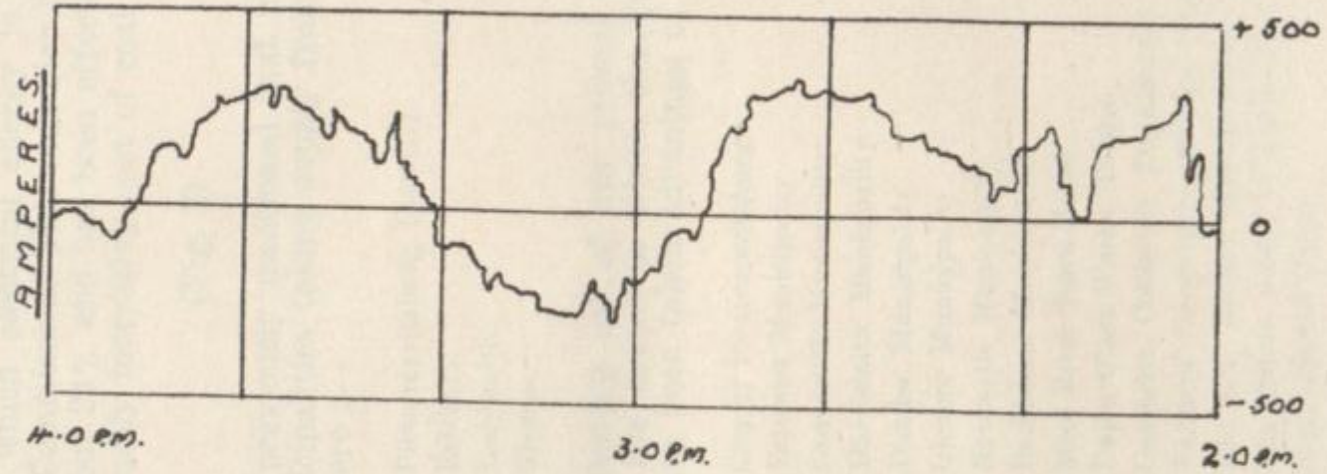


FIG 1

Year:	Average Failure Per Machine
1931	7.95
1932	7.78
1933	6.43
1934	4.13
1935	3.83
1936	2.39

During 1938 some of the motor generators will have completed their first hundred thousand hours of operation.

The final stage of the supply of direct current from both Rectifier and machine driven sub-stations is the operation of the protective apparatus against short circuits on the traction circuits and locomotives of the South African Railways & Harbours. The particular apparatus used for this—commonly referred to as the "high" speed circuit breaker equipment—was specially developed to limit the excessive commutation which occurs on direct current generation under short circuit conditions, a particular feature of its construction enables dual settings to be obtained on the one circuit breaker, the higher is the normal overload setting, whilst the lower, or short circuit setting, is that resulting from the rate of rise of current in the circuit protected.

The successful performance of this type of breaker is one of the essential necessities for Railway electrification where direct current is the motive power. The number of track faults dealt with during the past few years has averaged over two thousand annually. The larger proportion of these faults occur during sever thunder and rain storms.

BULK SUPPLIES :

The curve below (Fig. 2.) is not only a graphical history of the last ten years relationship between the "Undertaking" and a number of Municipalities and Local Authorities etc., it is also a record of

endeavour and achievement on the part of many Municipal Electrical Engineers who, through their special efforts, and with the assistance of their Committees, have brought about a development which has resulted in a general reduction in the prices at which electrical energy is purchased from the Commission. This reduction has amounted to about 24% and has been effected in spite of the steadily increasing cost of coal.

(Fig. 2)

I have previously mentioned that in 1927 the only Municipalities taking supply from the Commission were :—

Pietermaritzburg (partial).
Estcourt.
Ladysmith.
Glencoe.

The following list of our present consumers indicates the extent to which the Bulk Supply tariffs have been taken advantage of :—

City of Pietermaritzburg.
Estcourt Municipality.
Ladysmith Municipality.
Harrismith Municipality.
Dundee Municipality.
Glencoe Municipality.
Newcastle Municipality.
Bethlehem Municipality.
Mooi River Town Board.
Union Glass Works, Talana.
Cambrian Collieries, Dannhauser.
Farmers' Co-operative Dairies, Umlaas Road.
The S.A. Rubber Manufacturing Co., Howick.
The Cedara School of Agriculture.
Michaelhouse College.
Hilton College.

and the following South African Railways and Harbours non-traction supplies :—

Pietermaritzburg.
Daimana.
Thornybush.
Umlaas Road.
Cato Ridge.
Cato Ridge/Booth 6,600 volt line.

RETICULATIONS :

The establishment of Reticulations in order to supply current to individual householders became necessary when it was first indicated that certain small Local Authorities realised that they were not large enough to withstand the burden of an electrical staff, or the financing of a distribution system. In addition to this there were certain relatively small groups of residents in established townships who had not yet obtained Local Govern ment. Quite a number of these reticulations have been developed by the Commission. The following list indicates the extent to which this class of supply has grown :—

Volksrust Municipality.
Richmond Local Board.
Van Reenen.
Colenso Local Board.
Weenen Local Board (Under construction).
Waschbank.
Dannhauser.
Nottingham Road.
Lidgetton.
Merrivale.
Frere.
Camperdown.
Cato Ridge.
Umlaas Road.
Dansekraal.

In addition to the above there are several minor points of supply to individual houses or groups of two or three houses, and Railway Stations and Station quarters.

FARMERS' RURAL SUPPLIES :

Probably one of the most difficult of all problems is the provision of Rural Schemes for distribution to Farmers. As an example of the difficulties which have to be faced, the following schedule of material and light and power requirements has been abstracted from the estimates of a particular rural supply scheme :—

Number of consumers		25
—miles 6,600 volt line superimposed on existing S.A.R. & H. track structure ..	18¾	
—miles 6,600 volt cross-country line ..	19¾	
		38½
—miles L.T. connecting lines		2
Step-down transformer sets complete with lightning arresters pole fuses		22
Meters, service boards, etc.		25
Supply panel at Main Substation		1

The only source of revenue from the above proposition was to be that due to the occasional use of a number of electric motors with an aggregate of about 83 h.p. together with that from the installation of about 365 lighting points.

Comparisons between our estimates of revenue and expenditure and those from such countries as America and Canada seem to indicate that Natal is at a disadvantage as regards the density of the farming population. The average inclusive cost per mile of 6,600 volt three phase feeder line works out at between £250 and £300.

It must not be assumed that because the costs of reticulation in rural areas, and the small demand for current, together with the finance available, do not at present result in an economic equation in all areas, the question of their development will be allowed to recede into the background. It is part of the general responsibilities of the Electricity Supply Commission to make, eventually, their full contribution to the solving of such a national problem.

It is very obvious that with the widely scattered areas existing and in order to obtain greater development in rural farming areas, cheaper forms of construction are not only desirable, but necessary. This matter has received the serious consideration it deserves, and investigations are in progress.

It is a pleasing fact that the farming community are becoming electrically minded and fully realise the many advantages of electrical enrgy on their farms. In several of our schemes the farmers themselves have readily offered native labour and transport in order to help in the reduction of capital cost. At the moment there are four rural schemes in operation. The Merrivale Rural Supply, the Tweedie Rural Supply, the Richmond Rural Supply and the Dargle Rural Supply. The Weenen Rural Supply is now being established and will shortly be in operation.

THE 88,000 VOLT TRANSMISSION LINE SYSTEM :

The original transmission system extended from Pietermaritzburg to Glencoe and consisted of two separate lines running along relatively parrallel routes approximately one mile apart. In addition to the above, Tee lines were erected between the main transmission lines and several of the traction substations.

The switching equipment for feeding the transmission lines consisted of 6,600 volt iron-clad oil circuit breakers, used to energise and de-energise the 6,600/88,000 volt step-up transformers, one of which was linked direct to each of the four lines leaving the Power Station. This arrangement is still in use to-day and appears to be quite satisfactory for our existing needs. All step-down equipment, with the exception of three supplies, each with an installed capacity of about 300 k.V.A., is controlled by the use of E.H.T. oil circuit breakers. The three supplies mentioned above are controlled by 88 k.V. expulsion type fuse units.

During the period under review the original route mileage of 275 miles of 88,000 volt transmission line has been extended to Booth Junction at the Coast, to Volksrust over the Transvaal border, and to Bethlehem in the Orange Free State. This brings our total mileage up to 480.

At this stage it would seem opportune to give a resumé of the past ten years experiences with the original transmission lines. The large number of trips which were experienced in the earlier period of the undertaking indicated that the matter was one for routine investigation. This general investigation may be considered as having been grouped under two headings — Operating and Maintenance.

THE OPERATING INVESTIGATION :

The Control Department at Colenso was, of course, the natural centre for undertaking such observations. At this point, the value and location of all earth leakage currents was recorded, from which was deduced the approximate location of the fault. In order to determine the cause of the faults, the many outages were subdivided as either "having occurred during a thunderstorm" or they were "attributed to other causes." As there are forty-seven Railway stations along the route under review, each of these stations being connected to the general telephone system, it became a comparatively simple matter to obtain reasonably accurate information as to the existence, or otherwise, of thunderstorms at the moment of the fault, and in this connection it should be recorded that, owing to the known effects of thunderstorms on transmission line systems in general, it was of extreme importance that thunderstorms should be credited with the full number of trips which might be the result of such storms. When, therefore, any section of the 88,000 volt transmission system tripped out during the presence of a storm near that particular area, the fault was recorded as "occurring during a lightning storm."

THE MAINTENANCE INVESTIGATION :

From reports received as the result of special observations taken by the staff and also from additional information which was very kindly furnished by many of the farming community who were invited to report all interesting observations to the Electricity Supply Commission, it became apparent that birds might be, to a large extent, responsible for the high number of trips experienced. This fact was first publicly recorded by Messrs. J. A. West and D. S. Primmer in a paper read before the South African Institute of Electrical Engineers, Vol. XX. 1929. As however the number of outages being experienced at the time began to show an immediate and substantial decrease, it was hoped that the trouble was rapidly diminishing and no definite counter action was taken, but the practice of continuing the observations was maintained as part of the general practice of recording and analysing all faults on the transmission system.

In 1932 an increase in what was considered to be the bird menace was again apparent. The peak was reached in 1934 when 141 trips attributed to causes other than lightning, occurred on the original transmission system between Glencoe and Pietermaritzburg. It may at this point, be convenient to detail some of the conclusions arrived at with regard to the bird menace. The condition in which strings of insulators in certain more or less localised areas were found left no doubt as to the cause of a few of the line trips. These were due to excreta deposits resulting from cranes or storks resting on tower structures at points immediately over the suspended strings. The installation of anti-roosting devices consisting of saw toothed galvanised iron fixtures had the desired effect of causing the birds to select other portions of the structure as a resting place.

There is no proof that birds in general have any indication that the electrical conductors of our live transmission lines are unsuitable as per-

ches, until such times as they approach close enough to receive some definite form of warning. Most birds in Natal attempt to settle on live conductors, but are capable of, and always do, redirect their flight to another perch. The Ibis is quite incapable of any sudden redirection and generally flutters about until it is able to change its flight to another perch. It can be readily appreciated that although the behaviour of a single bird of the above species does not, of necessity, constitute a danger upon each and every occasion when a bird approaches a conductor adjacent to a string of insulators, it will be at once conceded that the behaviour of a group of twenty or more Ibises thoroughly enjoying themselves by pushing each other off the structure, with the result that several of them are left fluttering about next to the string of insulators or between the live conductor and the structure members is more worthy of the domestic fowl-run than of the classical history of Egypt. The result, however, was to bring about another outage on one of the transmission lines. As many as twenty-eight of these birds have been counted on one structure.

Another very important item in the investigation programme was the detailed inspection of each transmission line mast and equipment. In the report covering this section of the observations, records were obtained of all marks made by flashovers, and from these it was found that whilst in a number of cases the arc had established itself between the two protective arcing horns, it was also discovered that a certain amount of burning had occurred on the steel-work of the masts adjacent to the conductors and also on the conductors themselves at points away from the arcing horns.

It was at this stage decided to increase the clearance over a small section of one of the lines where it traversed ground known to be infested with the birds. This increased clearance was obtained by the introduction of two extra discs into

the existing string of six discs. All evidence of previous flashovers was eliminated and a further detailed inspection was carried out about twelve months later, and as it seemed from this re-inspection that the increased clearance so obtained, was a suitable method of reducing the number of flashovers being experienced, a technical investigation into the proposal was instituted with the result that it was decided to carry out the following alterations :—

All loops at Tension towers were lengthened in order to provide the maximum clearance between the looped conductor and the structure.

At suspension towers, other than those generally adjacent to transformer stations, two extra discs were fitted into the existing strings of the insulator to give the extra clearance required.

At the Power Station and Substations, mentioned above as Transformer Stations, it was decided not to raise the flashover value of the strings of insulators, as it was considered inadvisable to change the probable stresses on the transformer windings.

The above-mentioned modifications were put in hand during September of 1935 and completed twelve months later. Reference to the record of transmission line performances indicates that a real and definite improvement in transmission line performance appears to have been achieved as far as the bird menace is concerned, and although the return for the years 1936 and 1937 to date, indicates a better performance during lightning storms, it is too early to claim that the extra insulation of about 95% of the line equipment is responsible for the apparent improvement in a lay-out, where the general parth of thunderstorms lies across and not parallel with the transmission line route.

The design of the original main line transmission lines is generally well known to Engineers. The overhead earth wires and the underground earthing plate at each tower were incorporated in the original design. As these lines have never been a source of weakness during thunderstorms the lay-out and the material used has been acceptd as a contributory factor to their satisfactory performance in an area, where thunderstorms are at times not only numerous and severe, but indicate their severity by their effect on the 3,000 volt conductors used for traction haulage.

Apart from the routine inspection of individual strings of insulators by the Maintenance department, and the occasional replacement of insulator units, investigations are also carried out by the Test department with a view to detecting any unsuspected deterioration.

In order to confirm the actual condition of the insulation on our main trunk transmission lines, selected strings have been sent to the makers for a repetition of the complete series of tests which modern insulators have to undergo before they can be released for sale.

The certificate received have left no doubt in the minds of those responsible that the condition of these insulators is still satisfactory.

As previously mentioned, the original 88,000 volt transmission system has been considerably extended. The extensions in each case consist of a single three-phase circuit, the masts for which have been constructed of either second hand rails or of discarded boiler tubing from steam locomotives. These power circuits have been constructed and erected by the staff of the South African Railways & Harbours, along the routes used by the Railway. In some cases the high tension masts also carry a portion of the D.C.

track equipment, whilst in others the masts are used specifically for the purpose of supporting high tension conductors.

One might, at this point, remark upon the advantages which accrue from the use of the already established permanent ways as routes along which power lines have been run.

Whilst in a number of cases the lengths of the connecting roads between Cities, Towns and Townships are considerably shorter than those of the railway tracks serving these centres, any power line should of necessity make contact with the railway line at those points where electricity may be required for pumping, industrial or even complete electrification purposes. Apart from this consideration the simplicity of overcoming the servitude difficulties and expenses, taken together with the advantages of an already organised transport system, and the existence of an established telephone system, are very real contributions towards the reduction in capital expenditure. It will be a matter of some interest in the future to determine, whether the geographical position of lines with similar features of construction has any bearing upon the present comparative immunity of our transmission lines from the effects of thunderstorms in general.

RECORD OF TRANSMISSION LINE PERFORMANCES 1928 to 25th SEPTEMBER, 1937.

Original Transmission Lines.

1928	1929	1930	1931	1932	1933	1934	1935	1936	1937
Faults during lightning storms :									
12	15	14	16	22	*28	18	16	7	4
Faults attributed to other causes :									
82	174	86	56	69	85	141	117	49	16
TOTAL :									
94	189	100	72	91	113	159	136	56	20

MAIN 88,000 VOLT TRANSMISSION SYSTEM WHICH INCLUDES THE ABOVE LINES.

1928	1929	1930	1931	1932	1933	1934	1935	1936	1937
Faults during lightning storms :									
12	15	14	16	22	*28	18	19	13	8
Faults attributed to other causes :									
82	174	86	56	69	85	141	153	87	40
TOTAL :									
94	189	100	72	91	113	159	172	100	48

* Four of the above trips were due to stacks supporting disconnect insulators, which had depreciated badly, flashing through the porcelain during a thunderstorm.

HIGH TENSION DISTRIBUTION LINES :

The voltages selected for those feeder lines which radiate from the main transmission system, are chosen with respect to the special condition required to be fulfilled. At the moment there is one 33,000 volt line, 33 miles in length, feeding the Newcastle Corporation, one 11,000 volt line, 17 miles long, carrying the supply from Thornville Junction to Richmond and another of the same voltage being constructed to feed the Commission's reticulation just decided upon for the Weenen Local Board. The remainder of the Distribution feeders consist of fifteen 6,600 volt feeders with an aggregate length of over 95 miles.

Whilst these lines represent a much smaller item of capital expenditure than is the case with the main transmission system, they are subjected to similar routine investigation as regards reliability and suitability. Consistent records of all faults, outages and effects resulting from thunderstorms are all tabulated under the various insulator assemblies and types of protective apparatus, in use. Extracts from the last investigation which embodied several years operating experiences in Natal revealed the following :—

Conclusion I : That the use of earth leakage relay protection seldom resulted in permanent damage to any of the present line equipment.

Conclusion II : That insulator "A" has given better service than insulator "B".

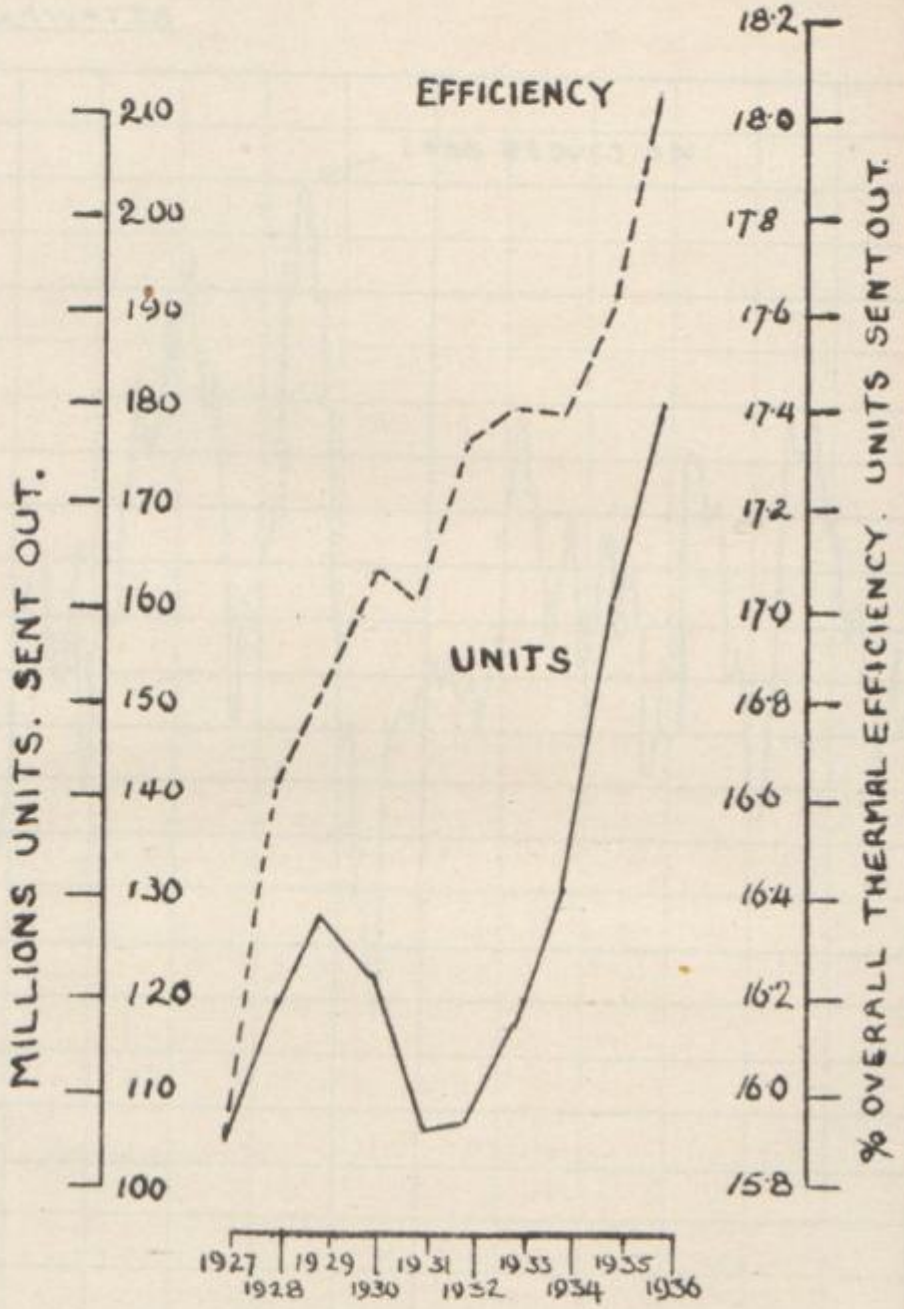
Conclusion III : That the "X" type of pin has proved more reliable than the "Y" type of pin, with regard to the complete rupture of insulators.

Conclusion IV : Of the various combinations in use, that consisting of earth leakage protection in conjunction with insulator "A" and "X" type of pin has shown a marked superiority over any other combination.

The letters "A", "B", "X" and "Y" have, of course, been introduced to avoid publishing the correct names of insulators and assemblies.

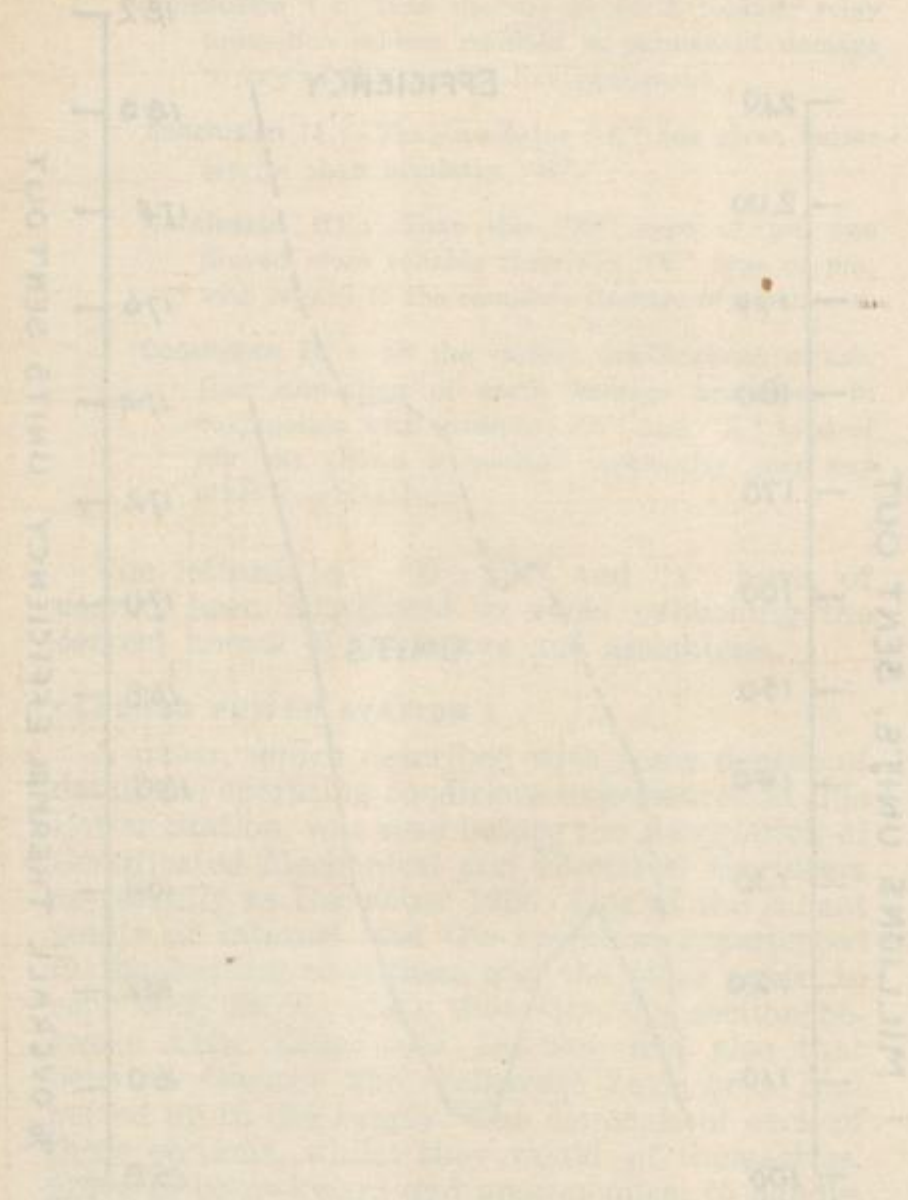
CLEENSO POWER STATION :

A paper, which described with some degree of detail the operating conditions experienced at this Power Station, was read before the Association of Certificated Mechanical and Electrical Engineers as recently as December 1935. One of the salient points of interest was the variation experienced in the loading conditions and the steps taken to cope with them. Since that date the section between Cato Ridge and Durban, and also that between Glencoe and Volksrust have been connected up to the supply. The demands of each of these sections, whilst they would of themselves, prove to be awkward and uneconomical to handle, have been combined with that existing previously for the common benefit. The theoretical explanation of this is "that of improving Diversity with increasing numbers." With about one hundred locomotives on the track each with a possible demand of a thousand kilowatts, the maximum possible instantaneous demand is about 100,000 k.W. The actual instantaneous maximum experienced for traction supply alone is somewhere in the region of 50,000 k.W. thus our diversity



ANNUAL VARIATIONS IN UNITS SENT OUT AND THERMAL EFFICIENCY.

FIG 3



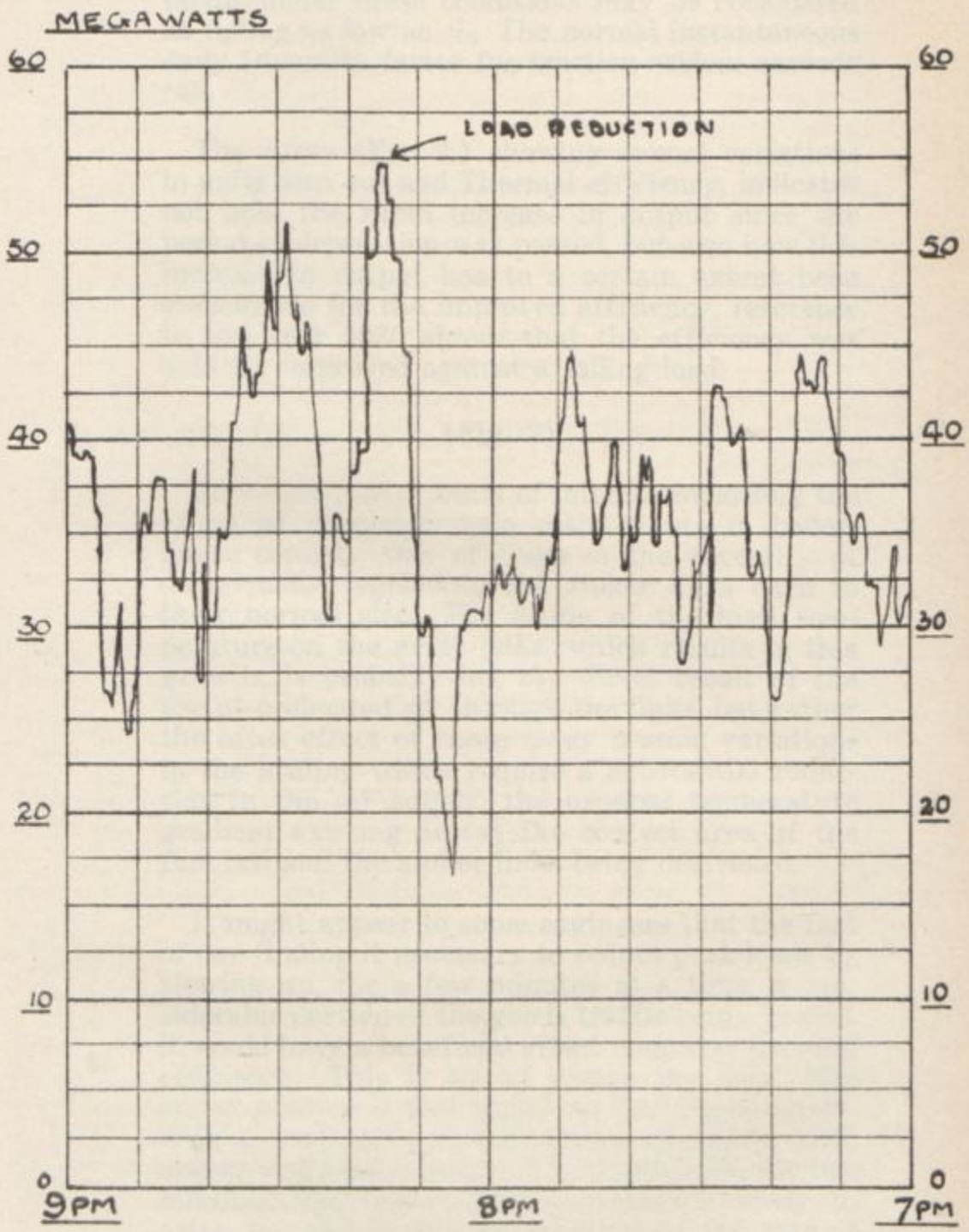


FIG 4

factor under these conditions may be considered as falling as low as ·5. The normal instantaneous daily Diversity factor for traction seldom exceeds ·45.

The curve (Fig. 3.) showing annual variations in units sent out and Thermal efficiency, indicates not only the rapid increase in output since the period of depression was passed, but also how this increase in output has to a certain extent been responsible for the improved efficiency, reference to the year 1930 shows that the efficiency was actually improved against a falling load.

(Fig. 3)

There are many points of interest regarding the effect of operation upon maintenance in boiler-house control. One of these is the necessity of occasionally regrinding the stoker links back to their normal size. The origin of the high temperature on the grate links, which results in this growth, is probably not the direct result of the use of preheated air through the links, but rather the after effect of those many normal variations in the loading which require a substantial reduction in the air supply, the original temperature gradient existing across the contact area of the fuel bed and the stoker links being destroyed.

It might appear to some engineers that the fact of our finding it necessary to reduce peak loads by slowing up, for a few minutes at a time, a considerable portion of the goods traffic being hauled, it would have a beneficial effect upon the Thermal efficiency. This is by no means the case. The actual position is that whilst our Turbo-generators, with a continuous R.M.S. rating of 12,000 k.W. and an overload capacity up to 20,000 k.W. for two minutes, can deal with any variation likely to arise the real limit is to be found in the rate of change in demand on the boilerhouse. Below will be found copies of curves taken from the Graphic Recording Megawatt Meter at Colenso Power

Station. In the first (Fig. 4.) it will be noticed that a variation in demand from 16,000 to 54,000 k W. necessitated a reduction in output. The reason for the low steam pressure, which made this reduction imperative, is to be found in the preceeding fifteen minutes when the demand on the eight boilers steaming was only about 75% of their normal rated capacity and the furnaces were, therefore, not in a condition to meet an increase during the next few minutes up to about 130% full load.

(Fig. 4)

Reference to the second curve (Fig. 5.) indicates however that eight boilers may be relied upon to evaporate sufficient steam in order to maintain an overload equivalent to 130% of full load provided the loading conditions preceeding the rise are close to the normal rated capacity.

The actual period and extent of these load reductions when taken collectively, is of minor importance as regards their effect on Thermal efficiency. It is usually necessary to reduce the load by amounts up to about 15,000 k.W. for a few minutes, and during 1936 the total period of this reduction was for under fourteen hours. The product of the total period of reduction and the amount reduced would approximate about 150,000 k.W.H.

This is actually equal to a transference of about ·07% of the load from the Peak condition.

THE CONTROL DEPARTMENT :

It is, of course, common practice to co-ordinate and direct all switching operations, in an undertaking of this size, from one central point, and in order to make this feasible, a complete schematic diagram, showing the major circuits or the whole system, is used in conjunction with a telephone exchange from which communication may be established with any point on the Undertaking.

Continuous attendance at this centre is maintained by the presence of one or other of the Control Engineers, whose primary duty it is to ensure, as far as possible the continuity of supply to each consumer. A replica of the Control Diagram (Fig. 6.) together with a map (Fig. 7.) showing the geographical layout of the system in general, is attached.

CONCLUSION :

Before concluding these notes I must ask you to appreciate the difficulty of describing, adequately, the progress and development of such an "Undertaking" in the short time at my disposal. Besides a general indication of the progress made, it has not been possible to more than touch upon one or two details in connection with the technical investigations.

At the moment the capital is approaching £4,000,000, whilst at the Power Station the capacity of the boiler plant will soon reach 720,000 lbs. of steam per hour. We also have at the Power Station and distributed throughout the Undertaking transformers with a total capacity exceeding 180,000 k.V.A. and in the very near future the total length of Transmission line feeders etc., will be nearly 700 miles.

It will be appreciated by readers that where the interest of Public Bodies, such as the Natal Central Undertaking of the Electricity Supply Commission. the South African Railways & Harbours and the many Municipalities and Local Authorities are identical ,as far as the Generation, Distribution and the several usages of electrical energy is concerned, goodwill must exist between them. Experience has shown that the close co-operation which has existed in the past, carries no small weight in the substantial foundations upon which the production and consumption of electrical energy is now resting.

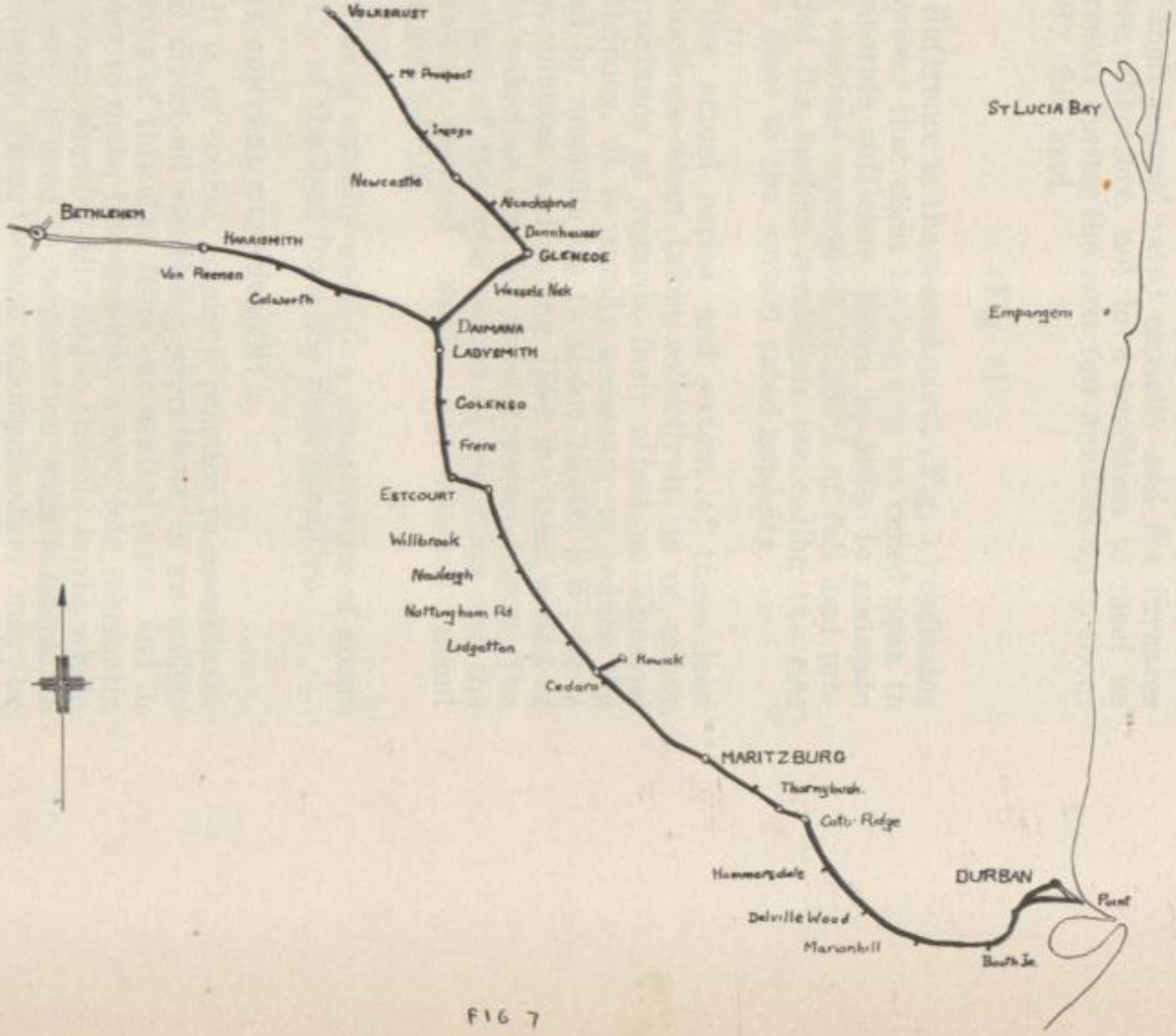

VOLKSRUST
Mt Prospect
Ingogo
Newcastle
Alcockspruit
Dornhauser
GLENCOE
Wessels Nek
BETHLEHEM
HARRISMITH
Van Reenen
Colworth
DALMANA
LADYSMITH
COLENSO
Frere
ESTCOURT
Willbrook
Nooldegh
Nottingham Rd
Lidgetton
Howick
Cedara
MARITZBURG
Thornybush
Cato Ridge
Hammersdale
Delville Wood
Marianhill
Booth Jn
DURBAN
Point
ST LUCIA BAY
Empangeni

FIG 7

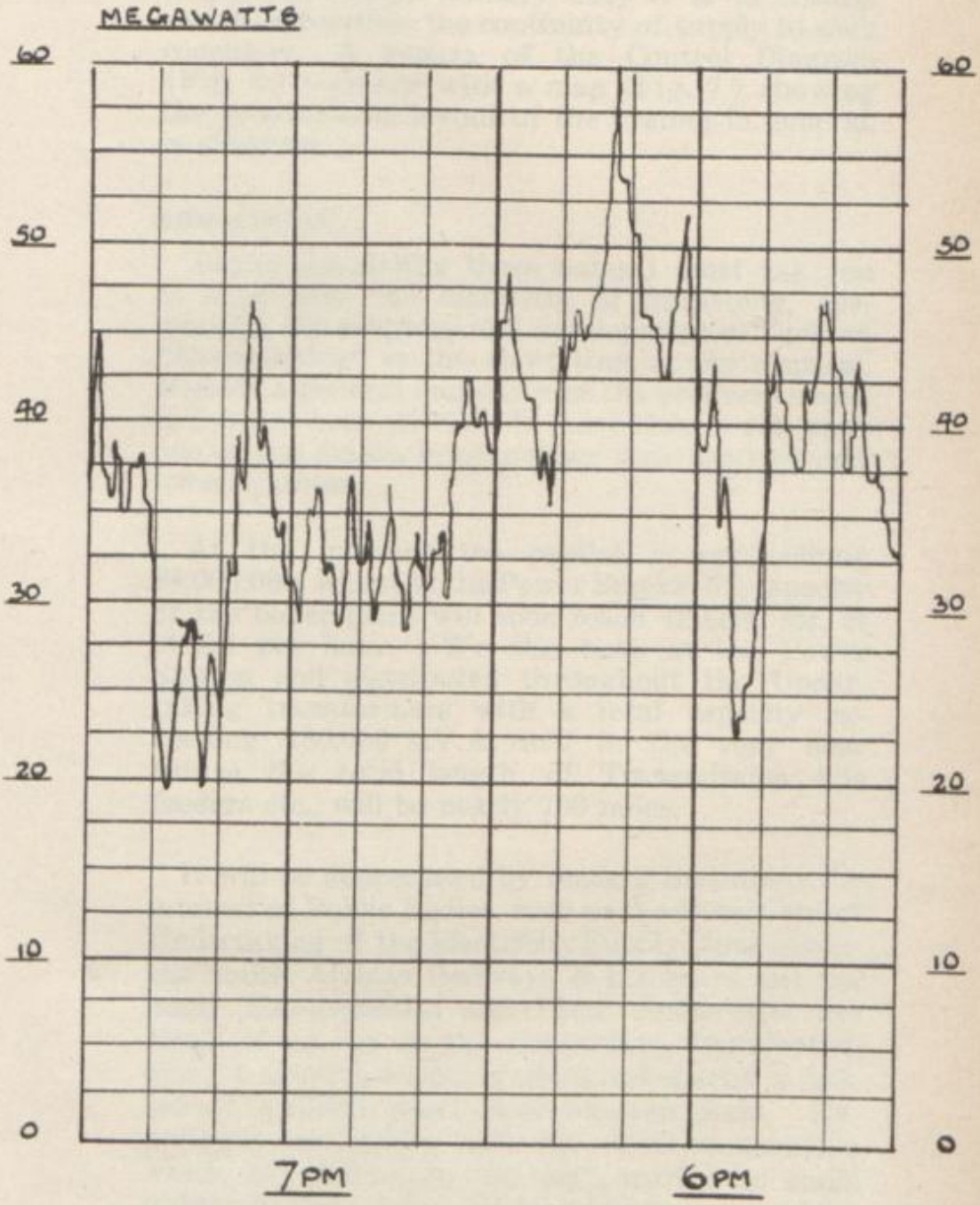
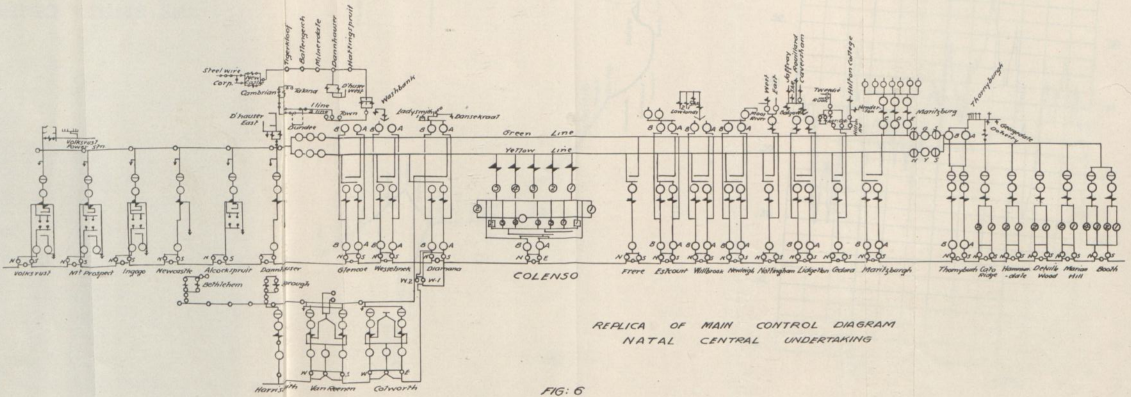


FIG 5



REPLICA OF MAIN CONTROL DIAGRAM
NATAL CENTRAL UNDERTAKING

FIG: 6

RURAL DEVELOPMENT :

I have been requested to refer to the type of construction used, and the cost of rural farm development. In the preparation of any scheme which is to be of advtantage to the farming community, there are several aspects to be considered. If the supply of current is to be a real benefit to the rural consumer, it should not only be reliable and suitable, but must also result in an economic proposition, and it is, therefore, essential that a true perspective of the services to be rendered should never be lost sight of.

The reliability of supply, when considered in relation to farming machinery need not be considered in exactly the same light as would be the case if the supply was required for—say an hospital, where the failure of current for more than a minute or two might easily be a matter of life or death, likewise; the consideration of the suitability of a supply required for irrigation or other farming purposes may be viewed with a little more tolerance than would be the case if the supply was required for a large city or industry. The economy of supply, however, must be of equal importance to every class of consumer, and it is this business factor which must be rigidly controlled if electrical energy is to be made generally available to those who should have the opportunity of using it, and in this connection it should be realised by all members of the industry that experience has shown once a rural scheme has been economically established, the consumers may be looked upon, not only as contributors to the general lowering of energy production costs, but also as permanent consumers of the electrical industry's many products.

South Africa is at some disadvantage when compared with other countries as regards the density of population. The actual position is that whereas many thriving rural distribution schemes exist in other countries, the number of consumers per mile of feeder generally shows a ratio of from four to one down perhaps to one to one. It will be

observed in the description of the two rural schemes mentioned below that in Natal the ratio cannot be conveniently expressed in terms of "consumers per mile" but rather it is advisable to use the term "miles per consumer."

LINE CONSTRUCTION :

It will be generally agreed that the fewer the number of points in a line where the electrical conductors are adjacent to and only separated from the poles by insulator assemblies the probabilities of interruption are lessened accordingly.

An increase in the average span length from 250 ft. up to 300 ft. reduces the number of insulators used by about 16%. This reduction may be considered in its relation to both capital cost and the continuity of supply. Likewise; the loading of the poles and conductors up to the safe mechanical limits is also a contributory factor towards the reduction in capital cost. In the Natal Central Undertaking the existing practice is to erect 6,600 volt lines to the following specification :—

Length of poles	30 ft.
Average weight of poles	280 lbs.
Average span length	300 ft.
Size of copper conductor	.160 in diameter.
Spacing	Triangular with 36 inch spacing. Top phase over pole cap.
Earth wire	No. 8 S.W.C. steel wire supported below conductors.
Cross-arms	One 3½" channel iron.

CONSUMER'S EQUIPMENT :

As a general rule the location of each consumer is such that a separate step down equipment becomes necessary. Particulars of a typical installation are given below :

Transformer :	Pole mounted 10 kVA star-interconnected star, or 2½% 6600/380/220 volt three phase four wire, with L.T. neutral earthed.

Fuses :	Three 6,600 volt link type expulsion, pole mounted. Three L.T. plug in type, pole mounted.
Lightning Arresters :	Three 6,600 pole mounted Thyrite pellet or oxide film type. Three L.T. pole mounted on similar type to above.
Low Tension Line :	As required, four wire with neutral wire insulated.
Service Connections :	A.M.E. lead in wires, with usual fuse cutouts and main switches, single phase meters and circuit fuses.

MAIN SUPPLY EQUIPMENT :

The supply to rural schemes is taken from the nearest convenient source available. This is generally to be found at one or other of the main substations in the vicinity, and usually consists of either a remote controlled oil switch from which supply can be resumed within about a minute, or an automatic reclosing oil switch which restores supply within a few seconds of its tripping. The relays used to protect the circuit are of the conventional overload and earth leakage type, but as practically all fault currents are due to line leakage, the earth leakage relays are not only set to operate at a low value, but the value of the fault current itself is limited to below the probable danger point by the use of comparatively small transformers connected up as earthing transformers.

Thus in a large traction substation, the source of the 6,600 volt supply may be an 88,000/6,600 volt 2,400 kVA transformer. The earthing transformer for this circuit consists of a 25 kVA star-interconnected star transformer with the high tension neutral earthed.

EXISTING RURAL SUPPLIES :

It will probably be of interest if further information is now given regarding two of the existing rural supplies. Each of these schemes was constructed with the assistance of farm labour and

the co-operation of the farmers themselves in helping with the transport of certain of the material from the nearest railway station.

In the first supply it was necessary to erect nearly 10.4 miles of cross country line of which 8.7 miles was at 6,500 volt pressure and 1.7 miles was low tension four wire construction. This averages out at 1.3 miles of line per consumer.

The whole cost of this scheme including all transformers and equipment was £2,893, which averages out at about £278 per mile. The average monthly consumption of units per consumer is about 700, but if the largest farming consumer is excluded then the average would only be in the region of 400 units per month.

In the second area, 7.26 miles of 6,600 volt line was constructed in addition to one mile of low tension line.

It was possible to make a substantial reduction in the capital of this scheme by arranging with the S.A.R. & Harbours Administration to erect 4½ miles of the 7.26 miles of high tension line, superimposed upon the existing 3,000 volt Track equipment structures in that area.

The original number of consumers was only six, and this gave a ratio of about 1.37 miles per consumer upon the original lay out. The number of consumers is now ten and the ratio has, of course, changed to 1.2 consumers per mile.

The capital cost of this scheme is £1,600 whilst the average monthly consumption per consumer is about 300 units.

It is only those closely associated with that section of the rural community situated within the zone of possible supply, who can appreciate that there is a high potential demand which can-

nance or the modification or extension of the existing equipment, becomes a very difficult and, at times, an almost impossible matter.

I hope these few remarks will give rise to some discussion which will make it possible to move a stage forward along the road of cheaper construction.

DISCUSSION :

The President : Your applause indicates the extent to which Mr. Penny's paper has been appreciated, and it is now open for discussion.

Mr. Muller (Krugersdorp) : In connection with the insulation I have wondered whether the protection of the earth wire has anything to do with it, I am not looking at it from the point of cheapness as much as from the point of efficiency, although I have been advised that the actual position is not very material. I would like to know what Mr. Penny has to say about that.

Mr. Sparks (Pietersburg) : I would like to thank Mr. Penny for his paper. In a small municipality we have found out a lot of things because we have not much money to spend.

We have just had to build a line to a farm school. This line is about ten miles long, and it cost slightly over £100 per mile. We did not go in for very high tension insulators; it is a fairly dry country, so why go in for expensive insulators. We also go in for wooden poles and put in low tension insulators on lines which have been operating for about six or seven years.

I quite agree that everything has to be considered on its merits, but we also have to use a certain amount of common sense. To keep costs down one must consider each and every factor.

Mr. Horrell (Pretoria) : In regard to what Mr. Sparks has just stated, I am sure many of us would like to have his recipe for a line costing

£100 per mile. (Hear, hear and Laughter). In regard to poles ,those put in at Pretoria by the Government are excellent. They have been in for a number of years and are still in excellent condition.

If Mr. Sparks will tell us how he managed to erect that ten miles of line for £1,000 we will be very grateful.

Mr. Rodwell (Johannesburg) : Mr. Penny has, in the short time allotted for the reading of the above paper, covered the activities of the Electricity Supply Commission's Natal Central Undertaking in a very able manner and is to be congratulated on the extent of and details included in the paper. Since the inception of the Natal Central Undertaking in 1927, remarkable progress has been made in the supply of energy to the major portion of Natal from the Colenso Power Station. Whilst the Railway Electrification of Natal consumes the major portion of the Undertaking's output, the nature of the load is such that extreme limits of demand are imposed upon the plant over short intervals of time. The extension of the distribution system to embrace bulk supplies to municipalities and rural electrification has very definite advantages as far as generation problems are concerned.

One of the striking features of the supply to the South African Railways and Harbours is the length of electrified track from Volksrust to Durban supplied from a single centrally situated generating station at Colenso. It would appear that, in this instance, definite advantages would be gained by interlinking the Congella Power Station (Durban) with the Natal Central System and from an economic point of view it is difficult to understand why this is not done. The increased cost per unit generated at Congella is apparent, but the difference in cost between the units generated at the Congella and Colenso Power

Stations will be largely discounted in the long distance transmission losses from the latter station.

The recent extension of the Railway Electrification scheme from Glencoe Junction to Volksrust will, no doubt, add many interesting problems, especially in respect to the maintenance of supplies to the converting sub-stations. The interconnection of the Natal Central Undertaking with the Rand Supply System is apparently not far distant. The question of controlled frequency of the latter system will, however ,be one of the major problems to solve.

The author refers to the economies effected in the use of "otherwise useless rails," whilst the use of the above rails for structural purposes has lead to a considerable reduction in capital cost per mile of track, the railway electrical engineering department is the only one to have benefitted as other departments, formerly using old rails for reinforcements, are now apparently precluded from using them.

With reference to the equipment installed for the converting of energy for traction purposes, the author refers to the economies effected by the adoption of mercury arc rectifiers. The economies are due mainly to the lower initial cost of the whole equipment, including buildings, lower maintenance costs and a high efficiency over a very wide range of loading.

The rectifiers rely mainly on grid control for the necessary compounding. This step was no doubt necessary due to the fact that the motor converters were already equipped with a certain degree of overcompounding. The use of grid control on rectifiers has, however, the disadvantage that harmonics are reflected to the A.C. and D.C. sides of the gear resulting in a certain amount of interference in communication circuits. Other forms of apparatus are available for use as voltage

regulators but, in general, the operation of such devices are unsatisfactory for traction systems due to time lag between change of load and completion of functioning of the regulator. The latter arrangement usually consists of tap changing devices, boosting transformers, etc , and since, on traction demands, the fluctuations in loading are severe, the regulating gear is constantly in operation resulting in unnecessary wear and tear.

The Undertaking is to be congratulated on the development of its bulk supplies to municipalities and reticulation of towns.

The latter scheme is of particular assistance in areas where the initial capital costs and subsequent maintenance charges would prohibit any electrical installation.

The question of rural supplies is probably one of the Commission's most difficult problems to solve, mainly on account of the low return on the initially heavy expenditure. It is questionable whether the cheaper forms of construction will assist in ensuring an ample return for the capital vested in such lines due to the very low density of population. It is realised however, that this is not the only consideration.

In connection with main transmission lines from Colenso, reference has been made to the lack of interconnection between generating stations and the apparently excessive length of transmission line from Colenso to Booth Junction. The duplicate outgoing lines, both to the north and to the south, are widely separated, thus ensuring a reasonable security against faiure of both lines. This security, however, diminishes with the length of transmission line, but it has also been noted that the insulation of the line has also been increased. The latter factor has had a remarkable influence on the number of outages of the lines, but as this increase in the insulation of the line has only recently been effected, the full value of the change-over has apparently yet to be appreciated.

The table showing the performance of the lines is of little value; a far better method of comparison being that of dividing up the length of line into sections which are either immune from faulting or otherwise.

The decrease in insulation resistance in the vicinity of transforming points has an important bearing on the maintenance charges of overhead lines, in that flash-overs and any breakdown of equipment is in general limited to areas where maintenance gangs are stationed. In connection with lightning surges, the question of permitting flash-over at the point of striking or allowing the whole line to be overstressed until flash-over occurs at the substation, is a debatable point. The author will, no doubt, be able to give further details in connection with this subject at a later date.

The author is not only a student of engineering but also of wild bird life. The ibis' characteristics have been described fairly fully, and this bird is probably the chief offender causing outages. The bird has the peculiarity of pushing rivals off transmission lines in order that the position of honour may be attained near the suspension point. The chief menace in this respect in the Transvaal is the hawk and the owl. These birds usually perch on the cross arms and arcing horns, the resulting excreta invariably fouling the insulators. Faulting due to bird menace usually occurs just before sunrise when it appears that these folk are particularly active.

I understand that the provision of bird guards has reduced the number of outages to a minimum. These protective devices take the form of projecting wires attached to crossarms immediately above the suspension point.

In connection with the extensions to the 88 kV transmission lines where the track masts are utilised for the dual purpose of carrying both H.T.

and traction supplies, I shall be glad to know whether the author has any records to indicate the relative immunity of the traction supply from lightning strokes. The permanent way in this instance affords a remarkably easy method of construction and the costs of procuring wayleaves, etc., are reduced to a minimum.

The author's concluding notes, dealing with the Colenso Power Station, reflects great credit on those responsible for the operation of that station. The increase in the diversity of demand has had a remarkable influence on the functioning of the equipment as a whole, as the loadings on individual sections are such that the function in total loading is reduced considerably. The possible electrification of branch lines will assist considerably in the reducing of variations in demand.

In conclusion I desire to thank Mr. Penney for his informative and interesting paper and we trust that the succeeding years will show an even greater advance than in the past. The writer's addition to his paper now submitted dealing with rural supplies gives considerable information which will be valuable to numbers representing small Undertakings and to those contemplating taking supplies from the Commission's Undertaking. (Applause).

Mr. Milton (Electricity Supply Commission): One of the aspects which interests me most in connection with this paper is that of cheap construction. I have been fortunate enough to see estimates for lines which have been constructed, and from what I have seen it does seem that a wooden pole might be adopted in this country, especially for rural supplies, and if we could have some definite information as to wooden poles it would benefit us very considerably.

Mr. D. W. Ritson (Stellenbosch) : I just want to say that Ladysmith, Harrismith and Maritzburg are practically on the same tariff, and I am

wondering if this is the same throughout Natal. The birds in Natal are the ibis, while we have the secretary bird and the hawk. It has been very interesting to hear about this, and the author has given us some idea of the disadvantages to be faced in Natal. I would like to congratulate Mr. Penney on his paper.

Mr. Jagger (Ladysmith) : I think it will be interesting to Members of our Association if I give a few points of interest with regard to the Ladysmith Undertaking. In the first place the nett Capital Expenditure at the change over, was approximately £12,000, and up to the present time this sum has not been increased. During the Corporate Year 1925/1926 the total units sold was in the region of 700,000, whereas to-day the output is 2,000,000 units per annum. In 1925 the average cost per unit to the consumer was 4.2 pence per unit, but to-day it is 1.7 pence per unit, a reduction of something like 150 per cent.

During the eleven years we have been receiving our supply of current from the Electricity Supply Commission, there have been only a few interruptions in the continuity of the supply. I think these few remarks may be of interest to Members representing Municipalities who may be considering the question of taking a supply of electricity from the Electricity Supply Commission. (App.)

Mr. Sparks (Pietersburg) : With reference to the cost of wooden poles, those used for the line to the farm school I mentioned cost £1 apiece, which is a total of £30 for 30 miles. Insulators cost about £11, and the material and labour came to about £76 per mile, including the transformer. The whole thing worked out at about £100 per mile. Quite by accident we discovered that low tension insulators would meet the case, and they have proved quite satisfactory. It would be very foolish to put high tension insulators on wooden poles in the same locality.

Mr. Hooper (Robertson : I want to thank Mr. Penney for his paper, but there are one or two points on which I would like a little further information.

There is the matter of the cost of the line and the reaction of lightning arresters. This is possibly due to local conditions in Natal.

The other point I would like some information on is in regard to fusing. I would like to know whether these links are of any value, although they are merely put in as section line switches.

With regard to the erection of lines, I have built lines of 11,000 volts at a cost of £125 per mile. It depends very largely on the cost of the pole and the size of the conductors. Both have a considerable bearing upon the cost of the job.

An important factor in connection with wooden poles is that of water soaking down. This can be prevented by using a sleeve of galvanised iron filled with sand to act as a protection to the creosote.

I would appreciate some information regarding the protection of small transformers and the ascertained value of lightning arresters.

The President : It might interest members to know that about 1915 we constructed a short line of Tram rails about 1½ to 2 miles long carrying high tension on top and low tension below which is still in use.

Two years ago we also constructed a line over a distance of about five miles largely composed of old tram rails, and I hope these will last quite as long as the other line.

Mr. Jones (Mafeking) : We have used Government gum poles treated with creosote and up to the present no damage has been done. We also

put barbed wire about 10 feet up the pole which had the effect of preventing Natives from climbing the poles.

Professor Clark (Natal University) : I must thank Mr. Penney for his most interesting paper. It contains a record of the excellent work the Commission is doing and gives an indication of the importance of the National service it is rendering.

I would like Mr. Penney to analyse the cost of £2,716 and to tell us what proportion of that is represented by the cost of the transformer.

REPLY BY Mr. PENNEY.

It is very gratifying to hear the various members contribute to the discussion on my modest effort.

In reply to Mr. Muller : The position of the earth wire in relation to the conductors need not be considered on medium voltage lines. The method adopted of fastening the steel earth wire to the poles should be such that the movement due to swinging is not suddenly terminated.

Replying to Mr. Sparks : The description of a 3,300 volt line, used for the specific purpose of supplying a farm school with a demand of approximately 25 kW. is interesting, in so far as he uses low tension insulators mounted on wooden poles, without an earth wire and with an insulated neutral.

This combination might give a suitable supply under particular conditions, but is is certain that any considerable addition to, or multiplication of such circuits, would eventually bring about a set of conditions where insecurity to the supply would appear and the probable safety of the existing arrangement would disappear.

One important aspect of the rural electrification problems is that there are no definite limitations to the area which might eventually

be served. Therefore the original layout, whilst it must on no account be burdened with a capital expenditure for future extensions, must be such that not only may increased insulation and voltage, be used when required, but additional circuits may be connected up to cover an increased area.

It has been the Commission's experience that the establishment of an agricultural industry in any area invariably results in a demand for labour saving devices and sometimes irrigation plant, and where a rural scheme is already in existence the electrical drive, due to its simplicity, has been found most reliable and economical.

It should not be overlooked that the circuit described by Mr. Sparks is for a limited load over a definite length and, therefore, the probable disadvantage of such a circuit may not often appear.

Mr. Horrell's experience with Government grown poles has apparently been very satisfactory. This has been the experience of many other centres. I am quite certain that the Commission's engineers would be only too pleased to use South African grown and treated poles on the rural supply lines, if their use would ensure the same length of life to equipment and reliability to supply under our special conditions, at a cost comparable with existing practice.

There can be no general objection to the use of these poles provided the location and the working conditions are suitable for their use.

Mr. Rodwell refers to the advisability of interconnecting the Colenso and Congella Power Stations. There are, of course, several aspects of such a suggestion. The existing 88,000 volt transmission line equipment between Colenso and Durban would limit the interchange of demands between the Power Stations to a comparatively low

value, and it is probable that the "constants" of the circuit would result in instability under fault conditions.

It may be considered, however, that an available interconnector of limited capacity would result in the provision of an alternate supply, which would make it possible to transfer a section of the load from one Power Station to the other, at a minimum of cost.

Bird faulting—Our experience has indicated that the greater percentage of bird faulting has occurred in the earlier hours of the day, starting at about dawn. The smallest percentage occurs during the hours of darkness.

The maintenance investigation referred to was a comprehensive report of the actual condition of all sections of the equipment which comprises the main transmission system.

In reply to Mr. Milton : The actual time during which a line is out of commission due to faulting is dependent upon the performance of the protective apparatus. As the power arc, which was perhaps established by a bird, or originated by a passing thunderstorm, is limited in time by the relay setting and in magnitude by the impedance of the circuit, is eliminated without any serious after effects, the line is invariably available for service almost immediately after it has tripped out.

Regarding the remarks by Mr. Hooper : The grading down of line insulators is often looked upon as a method of localising possible line troubles to a particular area, but the very means adopted to bring about this condition may be the cause of the trouble experienced. The installation of a few insulators which have a lower insulation value than the remainder in the line is, in reality, the introduction of insulators which may either have a lower puncture value or a lesser flashover

value. In the first case a hazard which may result in a prolonged stoppage is being introduced, whilst in the second, it is doubtful if the difference in flashover values would limit the discharge to the insulators with the smaller dimensions.

The use of lightning arresters is limited by the Commission to the protection of plant. If it were desired to use arresters for protecting the line from outages, then it would probably be found necessary to instal a large number of these, spaced at regular intervals along the line.

The fuse links referred to are simply a combination of a fuse and a link. It is possible to open them with a link stick and replace the fuse elements.

In answer to Mr. Harvey : The advantage of using star-interconnected-star transformers is to be found in the fact that the transformer is essentially of robust construction, the neutral points are available if required and third harmonic pressures are practically non-existant.

Replying to Professor Clark : The voltage of the earthing transformers mentioned in the paper is that equivalent to the pressure of the circuit protected.

In the case of the 6,600 volt rural supply lines a 6,600/380/220 volt star-interconnected-star three phase transformer is used. It is connected to the 6,600 volt terminals of the main 88,000/6,600 volt 2,400 kVA. star Delta transformer, and the neutral point of the 6,600 volt star winding is permanently earthed.

Bulk Supplies :

The Bulk Supply tariffs for the Natal Central Undertaking are at present :—

An annual charge of £25.
A monthly charge of 8/4d. per kVA
125,000 units per month at .2d.
All units thereafter each month .15d.

Mention has been made of damage caused to lines by Secretary birds and Hawks. Birds of these species have been responsible for a number of our line trips, but as the number of faults now being experienced during fine weather is only about 15% of the original level it is hoped that the modifications introduced to combat the antics of the Ibis are also effective for other types of birds.

It was very pleasant to hear Mr. Jagger state that the supply of energy under Bulk Supply conditions have proved so satisfactory and reliable during the past ten years. Any stoppage to a Bulk Supply consumer or a reticulation is always a matter for discussion and investigation by the Heads of Departments concerned, and it is by this process that the reliability mentioned by Mr. Jagger is finally achieved.

THURSDAY, 11th November, 1937.

The Convention resumed sitting at 10.5 a.m. in the Ball Room of the Marine Hotel, the President in the Chair.

SUB-COMMITTEE (Relief of Rates).

The President : Gentlemen, the Council suggest that the Sub-Committe to investigate and report upon the subject of contributions to the relief of rates shall consist of the following :

Cr. James (Cape Town).
Cr. Hofmeyr (Stellenbosch).
Cr. Robbins (Pietermaritzburg).
Cr. Coetzee (Springs).

and as engineer members :—

Mr. Behrens, Port Elizabeth.
Mr. H. A. Eastman, Cape Town (Vice-President).
Mr. J. H. Gyles, Durban (President).

Agreed.

CONVENTION INVITATIONS.

The President : With a view to reducing expenditure on printing the Council recommend that official invitations be discontinued but that the usual notices be sent to all those interested. It that approved ?

Agreed.

The President : I propose to observe the Armistice pause at 11 o'clock for a period of two minutes. To-day we have a paper by Mr. C. Kinsman, Assistant City Electrical Engineer, Durban, on "Earthing in Relation to Low Tension supplies of Electricity." I will ask Mr. Kinsman to read his paper now.

Earthing in Relation to Low Tension Supplies of Electricity.

By C. Kinsman, A.M.I.E.E.
(Assistant City Electrical Engineer—Durban).

Mr. Kinsman : I first have to thank you for the opportunity and privilege afforded me of presenting this paper. I felt that I was rather rushing in where others much better qualified than I dared to tread, but the interest you have manifested in this particular subject encourages me to believe that the resulting discussion will be productive of much that will be helpful to most of us concerned. (Applause).

Introduction :

This paper contains little which is the result of original work, but is mainly a record of practical experience on a distribution system, together with liberal extracts from various papers presented under the auspices of the B.E.A.I. Research Association.

It is impossible to dissociate earthing in its relation to the safety of the public from its relation to the operation of protective devices, and it is from both aspects that the question will be considered in this paper.

The principal statutory requirements are set out in the Factories Regulations in the following terms :—

> "All accessible metallic portions of electrical plant and apparatus, which though normally not forming part of any electrical circuit may accidentally become alive at

a pressure exceeding low pressure to earth, shall be either protected by an insulating covering or shall be connected to earth by a conductor of adequate cross-sectional area."

" 'Earthed' shall mean connected to the general mass of the earth in such a manner as will ensure at all times, an immediate discharge of electrical energy without danger."

" 'Low pressure' shall mean a pressure normally not exceeding 250 volts."

It is noteworthy that although the Regulations call only for the earthing of such metal work as may accidentally become alive at a pressure exceeding 250 volts, we read in another clause the following :—

"All electrical apparatus and conductors shall be so selected, arranged, installed, protected, worked and maintained, as to prevent danger as far possible."

This appears to render it necessary to adopt the same precautions in the case of low tension supplies as are stipulated for higher voltages. Whether this be the case or not, such precautions are advisable.

While there may be Engineers who are not entirely in agreement with the practice, it is nevertheless common practice to-day to earth the star or neutral point of the low tension windings of distribution transformers. It may be noted that under the Government Regulations such earthing is only obligatory in the case of installations underground in coal mines. In this paper it is assumed that the neutral or star point is earthed.

Resistance of Earths :

Most Municipal Undertakings have, in the past, been fortunate in that they have been able to avail themselves of a generally low resistance "earth" in the pipes of the local water reticulation

system. The introduction, in recent years, however, of the compressed asbestos type of pipe, has either deprived some Undertakings of this particular earthing medium or rendered reliance upon it decidedly precarious. The Engineer has had thrown upon him the responsibility for providing his own earthing electrodes.

Before considering the means of obtaining an efficient earth connection it is first necessary to consider the limiting ohmic value of an earthing system.

In the case of a 200 volt distribution main with a full load rating of 150 amperes, it is apparent that the total resistance in circuit with any earth fault on the main itself must not exceed .75 ohm in order to ensure the passage of sufficient current to melt the controlling fuse.

In the case of a house service controlled by a main fuse of 30 amp. rating, the total resistance in circuit with an earth fault must not exceed 2 or 3 ohms if sufficient current is to pass to melt the fuse in a short time.

In this connection, it is of interest to note that the I.E.E. Wiring Regulations require that the resistance of an earth electrode must not exceed 1 ohm and that where it is economically impracticable to obtain such a figure, earthing shall be supplemented by an earth leakage switch, adjusted to operate with a leakage current of not more than 30 milli-amperes.

Reference will be made later to the application of earth leakage switches.

Should the only return path for the fault current be through the ground, via earth electrodes, the necessity for the combined resistance of the earth electrodes being less than 1 or 2 ohms will be realised.

As an illustration of the failure on the part of some Engineers to realise the necessity for low resistance earth electrodes, the following incident may be quoted. A certain Engineer stated that he was satisfied with the efficacy of his neutral point earthing as he was able to obtain practically full glow on a 40-watt lamp, connected between a 200 volt line conductor and a test spike driven into the ground. As the resistance of a 40-watt 200-volt lamp is of the order of 1,000 ohms, it is possible for the resistance of the earthing electrode and the test spike to be as high as 100 ohms each; this will still pass sufficient current to cause the lamp filament to glow brightly but will pass only one ampere on an earth fault. Where the interruption of the supply to a faulty section depends upon the magnitude of the fault current, the foregoing remarks establish the necessity for careful measurement of the earth electrode resistances by means of the very reliable portable testing sets now available for the purpose.

Selection of Earths :

A great diversity of forms of earthing electrodes exists and it is feared that an even greater diversity in their ohmic values exists. One of the B.E.A.I. publications states that it was found that in four villages in England, twenty five per cent of the earthing electrodes had resistances of less than 10 ohms, thirty five per cent between 10 and 50 ohms, and in the remaining 40 per cent all were above 50 ohms.

It is not always possible to exercise a wide choice in the selection of the most suitable soil in which to bury an electrode. The resistivity of soils varies considerably, the most favourable being marshy ground and ground containing ashes, cinders, etc., while the least favourable is that consisting of dry sand, gravel and stones. The resistivity of the first class is of the order of 1,000 ohms/cm^3 while that of the last class is about 40 times as great. The presence of less than ½ per cent by weight of moisture of common

salt in the moisture of the soil may reduce the resistance of the electrode by as much as 80 per cent. A water-logged situation is not essential unless the soil be sand or gravel. Where it is possible to instal them the most satisfactory form of earth electrode consists of a number of rods or pipes of at least ¾ inch diameter, driven to a depth of 6 to 8 feet. The individual rods or pipes should be spaced at not less than 6 feet apart. The reason for this is that each rod or pipe has a certain resistance area, i.e., an area in which a measurable voltage gradient exists. The placing of a second rod in the resistance area of the first rod does not appreciably reduce the earthing resistance. When three electrodes consisting of ⅝ inch diameter steel rods were driven into favourable soil to a depth of 4 feet the following results were obtained :—

Average earth resistance of individual rods								11	ohms.
Resistance of three in parallel at						2″	centres,	7.8	ohms.
,,	,,	,,	,,	,,	,,	4″	,,	6.3	,,
,,	,,	,,	,,	,,	,,	1′ 0″	,,	5.0	,,
,,	,,	,,	,,	,,	,,	6′ 0″	,,	4.9	,,
,,	,,	,,	,,	,,	,,	12′ 0″	,,	3.9	,,

These figures show that the decrease in resistance depends upon the spacing to a greater extent than upon the increase in the area of the electrode.

Cable sheaths and water pipes should be connected to rods and pipes and used as earth electrodes.

If the space is inadequate for the resistance required or where digging is made difficult by rocks, etc., a form of plate is usually used as an earth electrode.

As it is necessary to make the area of ground covered by an electrode as large as possible, the plate form of electrode should be extended into strip form. A very efficient form of electrode of

this type is one composed of strips, approximately 1″ x ⅛″, laid radially from a centre at a depth of about 3 feet and connected in parallel. Tests which have been made indicate that the thickness of the metal composing an electrode does not have an appreciable bearing upon the earthing resistance. The factors governing the thickness of the metal are considerations of reasonable mechanical strength and length of service life where possibilities of corrosion exist.

In order to compare the efficiency of various forms of earth electrodes, certain tests were taken under the following conditions. The ground chosen was excellent for the purpose, being on the edge of a swamp. Three forms of electrode were buried for several weeks in order to permit consolidation of the ground around the electrodes.

The forms of electrode used were :—

1. A copper plate 18 inches square and ⅛ of an inch thick, buried 4 feet deep.

2. A copper strip 18 feet long, 1½ inches wide and ⅛ of an inch thick buried 4 feet deep.

3. Three steel rods, ⅝ of an inch in diameter, buried vertically to a depth of 5 feet, spaced 8 feet apart and connected in parallel.

The area of metal in contact with the ground was practically the same in each case.

The results were as follows :—

1. The earth resistance of the plate was .. 2·7 ohms.
2. ,, ,, ,, ,, ,, strip was .. 1·0 ohms.
3. ,, ,, ,, ,, ,, rods were .. 1·7 ohms.

The superiority of the strip over the plate is most marked. The strip was even superior to the rods but this is probably due to the ground being uniformly wet. Had the surface layers been drier than those lower down, the probability is that the rods, by reason of their greater depth would have given better results than the strip.

The provision of coke breeze around electrodes and the introduction of salt into the soil surrounding electrodes have the effect of lowering the earthing resistance and it has been suggested that as coke breeze has a negative temperature resistance characteristic, the earthing resistance of an electrode installed in this manner will fall with increasing current flow. In the case of salt in the soil, the heating of the earth on the passage of current, while evaporating the moisture, will effect a concentration of the salt. Should such effects actually be present during the passage of current, they will greatly improve the efficiency of the electrodes.

Having established a satisfactory earth electrode, periodical tests should be taken of its resistance.

The reason for these periodical tests is that the moisture content of the soil may undergo considerable seasonal changes and an electrode which is installed during the rainy season may give good results soon after installation, whereas its earthing resistance may arise considerably six months later.

It has been found that electrodes which reach a greater depth than about 4 feet, such as rod or pipe electrodes, do not show much seasonal variation in respect of their resistance, while plate electrodes, buried at a depth of about 3 feet, undergo very marked seasonal changes of resistance. This is what might be expected from a consideration of the moisture content of the soil at varying depts, and at different seasons of the year.

It may be essential and in any case it is advisable to make provision for the soil in the immediate neighbourhood of electrodes being kept damp by artificial means.

In suburban or rural districts this might easily be achieved by installing the earth electrodes in the vicinity of the water discharge pipes from the house.

Method of Connection :

Particular attention should be paid to the various connections on the earthing system. Connections which may have to be made below ground such as in the case of a buried earth plate should be both electrically and mechanically sound e.g., rivetted or bolted and soldered—and in order to protect the connection against the possibility of corrosion, it should be carefully compounded. In the case of pipe or rod electrodes, these should project above ground level so that the connections thereto may be visible for inspection at all times. A point which is liable to be overlooked is the necessity for an adequate cross-sectional area of copper for the earth wire. The melting point of copper is in the region of 2,000° F., while that of tinman's solder is about 400° F. If the cross-sectional area of the earth wire is too small, there exists the possibility of a very heavy earth fault current, particularly if it is of some duration, raising the temperature sufficiently to melt the conductor out of a socket, thus effecting an open circuit in the earthing system and leaving the installation without adequate earthing.

Protection of Installations :

As will have been seen, the establishment and satisfactory maintenance of earthing electrodes so that they have a resistance of one or two ohms, presents, in many cases, great difficulty. This difficulty has induced Engineers to investigate alternative methods of so protecting installations as to remove all danger of shock to persons.

The development which has taken place in the domestic use of electricity in recent years has increased the demand of the average domestic installations from about four or five amps to somewhere about twenty five or thirty amperes. Taking the case of a house service fuse with a continuous load rating of thirty amperes, this fuse, if it complies with the B.E.S.I. specification, will carry 1.6 times full load current or forty-eight amperes for over thirty minutes, and it will operate

with 1.9 times full load current or fifty-seven amperes in somewhere about eight or nine minutes. Supply engineers are thus faced with the problem of ensuring rapid isolation of a faulty installation whose main fuse will probably be of thirty ampere rating. To ensure this rapid isolation, the Engineer has the choice of any one of the methods to be briefly discussed or even of a combination of several of the methods. So many factors, some local and some general, have to be taken into consideration when making a decision on this subject, that it is hardly possible to arrive at any definite conclusions in a paper such as this. The factors attendant upon each particular distribution system will govern the policy for that system but it is submitted that the evidence adduced in this paper is sufficient to establish the impracticability of ensuring adequate protection by means of direct earthing alone.

There are various possible solutions to the problem which may be classified under the following headings :—

1. Local earthing electrodes with direct earthing.
2. Earth leakage switches.
3. Continuous earth wires.
4. Underground cables.
5. Protective multiple earthing of the neutral.

1. Local Earthing Electrodes with direct earthing.

The difficulties attendant upon this method have already been discussed and are such as to render this a very difficult if not impossible solution.

2. Earth Leakage Switches.

Earth leakage switches which interrupt the supply on the occurrence of a potential on the earthing system, of 15 volts or on the passage of a current of 30 milliamperes are available and are claimed in some quarters to be a complete solution of the problem as they function with a local earth

connection of a very high resistance. In Germany, where this system has been extensively used, its popularity may be attributed to the demand created by rural supplies. The difficulty of obtaining satisfactory earth connections, in rural schemes, considered in conjunction with the inflammability of thatched roofs, barns, etc. and the known susceptibility of cattle to the effects of electric shock, make some sensitive form of rapid isolation essential and the advantages of earth leakage switches in this respect outweigh their disadvantages. In urban and suburban supplies, the system has one very marked disadvantage. In order to afford complete protection in the case of a house installation supplied by overhead mains, it would be necessary for the switch to be installed on the pole in the street and in the case of an underground feed, for the switch to be installed on the meter board. In each instance the occurrence of a small earth fault anywhere in the installation will cause a complete interruption in the supply. The case of a large block of flats would be even more serious. The distribution of fault current between adjacent conduits in a duct may quite conceivably cause every earth leakage switch to operate and interrupt the supply to every flat in the building.

Whilst affording the maximum protection this method will undoubtedly occasion undue inconvenience and will in fact practically render abortive the present sectionalising of an installation by means of the distribution board. In its present state, simple earth leakage protection does not completely solve the problem except in the case of individual appliances such as electrical hair clippers and other appliances which must be immediately disconnected should the insulation fail.

3. Continuous Earth Wires.

A continuous earth wire, satisfactorily earthed at suitable intervals, and carried along the poles of the overhead line affords a very effecient

medium for the earthing of the installations supplied by the overhead line, although it entails the provision of a separate earth wire from the street to the house. This method offers a satisfactory solution from the electrical aspect but has certain objections. In regard to objections on the score of expense it will be agreed that the cost of the additional wire is relatively small and probably justified by the security afforded. The other possible objection is that the introduction of an additional wire in the service "pull on" will render the overhead service wires even more unsightly than they are at present. This latter objection might be met by usuing a twin conductor for the neutral, the additional conductor being used for the earth wire and connected to the continuous earthing system of the installation.

4. Underground Cable Distribution.

Distribution by means of lead sheathed underground cables affords a very satisfactory solution of the problem, although the conversion of an overhead system to underground or the adoption of the underground system, solely from a consideration of satisfactory earthing would be definitely uneconomical. Certain estimates prepared in Durban of the comparative cost of supplying low tension mains, house services and street lighting by means of overhead mains and underground cables showed the ratio of costs to be approximately 1 to 1·8.

Where, for any reason, the supply is by means of underground cables, efficient earthing may be provided by supplying each installation with an earth wire bonded to the sheath of the service cable. It is assumed that the lead is efficiently bonded across each joint.

Quite apart from the lead sheath being in partial contact with the soil, particularly at joint boxes, the resistance of the lead sheathing of low tension

cables, manufactured in accordance with the latest B.E.S.I. specification, is as follows :—

·1	L.T. 3-core cable.	·166	ohms per 100 yards
·06	,, ,, ,,	·195	,, ,, ,, ,,
·04	,, concentric cable.	·230	,, ,, ,, ,,

From considerations of voltage regulation, it is improbable that a distributor cable would be longer than 600 yards; this would give a resistance of approximately 1 ohm for the lead sheath of the ·1 3-core cable, which would permit the passage of nearly 200 amps on the occurence of an earth fault at the end of the cable. Burning off of the cable at the fault, before the "blowing" of the fuse is commonly due to the overfusing of the circuit.

In any case it is advisable for consumers earth wires to be bonded to the cable sheath, even where local earthing is adopted, the one system being supplementary to the other.

5. Protective Multiple Earthing.

This system is being rapidly developed and used in a number of countries, although its use is at present somewhat restricted in the United Kingdom. In the latter country, the regulation prohibiting the earthing of the neutral at more than one point delayed the development of the method, although to-day it is permitted in certain circumstances with the consent of the Electricity Commissioners.

It consists of using the neutral conductor as the earth connection for all earthed metal work in an installation and in effect converts an earth fault into a "short circuit," thus, ensuring the passage of sufficient current to operate the protective device controlling the particular circuit.

As against this particular advantage, which is a very marked one, there are certain dangers to be guarded against, otherwise the adoption of this

system may introduce even greater hazards than it is intended to remove. By reason of their connection to the neutral conductor, the frames of all apparatus and all tubing will be, at all times, at the potential of the neutral conductor. Under normal conditions, this potential will be very low and insufficient to cause a dangerous or even unpleasant shock. Under abnormal operating conditions, however, such as would occur on the occurrence of a heavy short circuit between a phase line and the neutral, momentary abnormal potentials may occur on the neutral conductor and on all metal work connected thereto. Should a breakage of the neutral service wire occur, and this is a distinct possibility where branches of trees may be blown on to service wires during heavy winds, a potential equivalent to the full supply voltage will exist on all metal work connected to the neutral conductor, should any switch in the installation be closed. Such eventualities must be very carefully guarded against if multiple protective earthing is used.

In order to provide against the breakage of a neutral conductor, it is usual to insist upon the earthing of all metal work being made to a continuous earthing conductor which is connected to the neutral conductor at its point of entry into the building. A local earth electrode is installed, from which an earth connection is carried to the point of junction between the installation earth wire and the neutral conductor. At the point at which the service wires are pulled from the mains in the street, a loop of copper wire, connected to the neutral service wire is so disposed around the "live" conductor that a breakage of either service wire will cause a short circuit between the live wire and the neutral, thus ensuring the operation of the pole fuse.

This system has been in satisfactory operation on portions of the local distribution, where no water supply system exists, for a number of years.

In case of a failure of the guarding, just described, when a neutral service wire breaks, the local earth electrode is intended to limit the potential rise on earthed metal work in the installation. Should there be no local earth electrode, the breakage of a neutral wire outside the installation will, if any switch is closed, cause full supply potential to occur on all earthed metal work. In the case where an earth electrode is provided however, the potential will be limited to :—

$$E \frac{R_E}{R_L + R_E}$$

where E is the supply voltage, R^L is the parallel resistance of the connected load and R^E is resistance of the consumer's earth electrode. If the supply voltage is 200, the load switched on is 1 k.W. and the resistance of the earthing electrode 10 ohms, the potential of the earthed metal work in the installation will be limited to 40 volts. Should there be a heavier load switched on or should the resistance of the earth electrode be greater than 10 ohms, then dangerous potentials may occur. It is here that the earth leakage type of switch appears to offer a very useful adjunct to the system of protective multiple earthing. If the operating coil of an earth leakage switch were connected between the neutral and an earth electrode, it would operate when the potential of the neutral rose above the pre-determined limit of about 30 volts.

This combination appears to offer as complete a system of protection of installations as is possible, consistent with freedom from unduly frequent and extensive interruption in the supply.

In regard to protective multiple earthing of the neutral, it should be clearly understood that in this paper the case of alternating current supplies only has been considered. It would be inadvisable, if not dangerous, to treat a direct current system on similar lines, owing to the possibility of electro-

lytic corrosion of buried pipes and cable sheaths being caused by vagabond currents in the earth. Such a danger is very remote if not entirely non-existent in the case of alternating current supplies.

Protection of Appliances :

Which ever method for the general protection of installations is adopted, there still remains the question of the protection of individual appliances. Again, the extensive development in the use of electricity in all directions is increasingly presenting problems for those responsible for drafting wiring regulations. An example of such a problem is the use of electrical hair clippers in Hairdressing establishments. Superficially it may appear that the use of a three-pin plug system to ensure the earthing of the frame of the appliance is that that is necessary. Generally, this may be so, but if one considers the possibility of the metal framework of the hairdresser's chair becoming accidentally charged through the portion of the concrete floor upon which it stands containing a faulty circuit, then by deliberately earthing the frame of the appliance, there has been introduced the possibility of a person sitting in contact with a charged chair and having applied to the back of his neck an earthed plate—a modification of the "hot chair" used in some of the States across the Atlantic. This instance is not given with a view to raising a bogey or creating distrust of electrical appliances but as a striking example of the hazards which might be introduced by indiscriminate "eathing" without a due consideration of all the circumstances. In this instance, there may be differences of opinion as to whether it is preferable to earth both chair and appliance or to insulate both and to ensure the maintenance of such insulation by means of an earth leakage switch. An alternative method of dealing with such appliances might be the requirement that they be only operated through a transformer designed to reduce the voltage to less than ten volts.

The restriction of space in the smaller flats recently erected has brought to notice a potential source of danger in the location of plugs. The Kitchenette is usually so small that it is almost impracticable to locate a plug at a greater distance than six feet from the sink. The consequence is that a person wishing to fill an electric kettle will, without disconnecting at the plug, carry the kettle to the tap and while holding the kettle in one hand will turn the tap with the other. Should the kettle not be wired on the three-pin and earth wire system, the consequences, in the event of a leak occuring on the kettle, may be serious.

These instances are given to show that while earthing is undoubtedly capable of safeguarding the public and users generally from the dangers of exposure to electric shock, careful consideration must be given to all the attendant circumstances.

Regulations and Control :

The Regulations framed under the Factories Act, in so far as electrical plant and machinery are concerned, only lay down certain very wide principles governing safety and define very carefully the allocation of responsibility in the event of any accident due to a breach of the Regulations. Regulations specifying in detail the standards of materials and workmanship and the actual policy to be adopted in particular circumstances and situations are at present left in the hands of the various Municipalities or Supply Authorities. As is only to be expected, there exist at present varying standards of control under the different Regulations, whereas a standard set of Regulations, which might be adopted by all Municipalities, would tend to bring about uniformity of policy as well as increased safety to the consumers and users of electricity.

The Regulations for the Electrical Equipment of Buildings, drawn up by the Institution of Electrical Engineers, are very complete and lay down specific instructions in regard to such points as

the limiting of earthing resistance of electrodes and the maximum resistance of runs of conduit, amongst other points. Regulations similar to these, applying to all Supply Undertakings in South Africa, are very desirable and it is understood that your Association has devoted much attention to such a set of Regulations, which, when issued, might with great advantage be adopted by all Supply Undertakings in the country.

References :

The resistance of Earth Electrodes (E.R.A. Report) P. D. Morgan and H. G. Taylor.

An Investigation of Earthing Resistances— P. J. Higgs.

Various Articles on "Artificial Earthing"— T. C. Gilbert.

Mr. Kinsman added : Since writing this paper I have had an opportunity of persuing the Supply Regulations. At the short time at my disposal I have not had an opportunity of studying these regulations very carefully, but I did not notice anything covering the question of multiple earthing of the neutral. In view of the difficulties explained in the paper in providing low resistance earthing, there should be some regulation covering multiple neutral earthing. Despite the advantages of mutiple earthing, it should not be carried out without very careful consideration of certain points, otherwise it may introduce the very dangers it is intended to remove. (Applause).

DISCUSSION :

The President: Gentlemen, your applause signifies how greatly you appreciate this most valuable paper, which is now thrown open for discussion. I trust the discussion will prove very useful, as I feel that this paper will be frequently used as a reference.

Mr. Rodwell (Johannesburg) : Mr. Kinsman has presented us with a paper on a subject of prime importance. His choice of subject is more than welcome for one is led to suspect that elec-

trical engineering science has a long road to travel yet to reach finality on the question of earthing, if one may judge by the large volume of contraversy and variation in practice extant at the present day. We are indebted, therefore, to Mr. Kinsman for leading us further on our journey in so illuminating a fashion and for bringing a spotlight to bear on this Cinderella of Electrical Engineering, so apt to be slighted with subsequent regret.

There seems to be as yet little consensus of appreciation of what constitutes a "dangerous voltage" nor by what unforseen means such may rise. This, in the absence of rigid enforcement of really comprehensive regulations, coupled with the resultant possibility of incompetent contractors embarking on schemes of maximum profit with minimum effective design and material,leads one to a fresh appreciation of the significance of the modern maxim "Live Dangerously."

Experiments to determine what constituted a dangerous voltage to human life revealed that the average man could endure no more than about 65 volts, A.C. and 130 volts D.C. when grasping a copper electrode in either hand with the hands normally dry. Voltages in excess of the above gave rise to muscular contraction preventing the ability to release the electrodes.

With the hands wet it was considered that even 50 volts, A.C., at commercial frequency might prove fatal to a normally healthy individual.

When one considers, in addition to the above, the variations in physical health of individuals and the numerous possibilities of exposure to electrical potential, it seems almost paradoxical that supplies should be given to the general public at 220 volts with out special attention to the installation and maintenance of adequate earthing facilities.

Mr. Kinsman has provided us with very illuminating figures relating to the requisite values of resistance of earth paths in contradistinction to the excessively high values so frequently, and often unavoidably, found in practice. The fact must be faced that human life may be endangered where the resistance of the earth path is excessive and that in such circumstances there are few precautions which are not fully justifiable, even in face of economic considerations and the possibility of inconvenience to adjacent consumers. It has been held that the provision and maintenance of really effective earth paths should be considered as important as continuity of supply, in fact, even more so.

But, as Mr. Kinsman rightly points out, the mere provision of an earth path is not an adequate protection to consumers. It will be freely admitted that there are few, if any, power distribution schemes on which it is possible to maintain each and every earth connection at a low enough value of resistance to ensure the immediate blowing of the appropriate protective fuses, nor is it possible by any existing method of earthing to achieve such optimum conditions generally. It is the appreciation of this fact that has led Continental and other engineers to acknowledge the value of earth leakage trips as rendering a poor earth connection sufficiently sensitive to ensure adequate protection. Surely South African Engineers will be prepared to accept the latest gift of modern progress as yet another step nearer a difficult goal. Admittedly, earth leakage protection has its drawbacks but it cannot be acknowledged that these are insurmountable.

The author mentions, for instance, the possibility of a minor fault in a block of flats occasioning the isolation of the entire building. This may be true of many existing buildings but it need not apply to new buildings in which each flat could be arranged to have its own protective switch, bearing in mind the low cost of such units. Suit-

able arrangement of conduit could prevent a fault in one part of the supply affecting another point. Such would surely be preferable to the risk of occasioning dangerous potentials on all apparatus throughout a building which may be connected to an ineffective earth system.

The author has drawn our attention to the fact that the I.E.E. Wiring Regulations postulate the installation of earth leakage protection in all cases where the resistance of the consumer's entire earth path exceeds one ohm. It should be possible to initiate similar constructive legislation applicable to electrical installations in this country by statutory requirements which are clear and definite in contradistinction to the somewhat vague provisions abstracted by the author from the Factories Regulations as now existant.

The methods to be adopted in the measurement of earth resistance paths call for some attention. In the first place it will be necessary to include for suitable provision to ensure the maintenance and testing of earth path resistance to take into account such seasonal and other variations as may render the earthing provisions inadequate.

Secondly, the method of measuring earth resistance should be clearly defined. As is well known there are two major effects, other factors being equal, which may give rise to false estimates of earth resistance — namely, Electrical Endosmose and Polarisation.

The first mentioned effect tends to occasion the movement of soil moisture away from that electrode from which the current is flowing, so varying the conductivity of the surrounding soil.

The second effect is due to electrolysis of the moisture and tends to partially insulate the electrode by the formation of a gas film.

These effects both point to the unwisdom of endeavouring to measure earth resistance by means of direct current. It should, moreover, be

borne in mind that the disturbing effects and duration of a fault current may be much more considerable than those of test conditions, and ample allowance should be made for this.

Due attention must of course be given to installing earth connections of a loading capacity adequate to the maximum possible fault current likely to arise. In this respect it is worth considering the conditions obtaining when a cable sheath is used as an earth return.

The following table illustrates the fact that the larger the cable current-carrying capacity the less suitable the lead sheath as an earth return :—

Single core 660 volt paper insulated cable.

Nominal copper sectional area	**(sq. in)**	**0.04**	**0.20**
Thickness of lead sheath	(in.)	.060	.070
Thickness of dielectric	(in.)	.080	.080
Overall diameter of conductor	(in.)	.260	.581
Cross-sectional area of lead (approx)	(sq. in)	.090	.179
Volt drop per unit length of sheath compared with that in copper (assuming the conductivity of copper 12 times that of lead		5.3 times	13.4 times

Thus, the larger the conductor the less the current capacity of the sheath relative to the copper. This is due to the fact that it would not be economic to increase the lead section in view of its poor conductivity and in view of the ability to use a bare copper earth return.

In reading Mr. Kinsman's valuable paper, in which he gives a bird's-eye view of this problem involving so many complex variables, one is led to the conclusion that even the provision of what seems a suitable earth connection at the time of installation does not leave the electrical engineer's mind entirely confident that such conditions will be maintained indefinitely. In short, since implicit reliance cannot be placed on earthing provisions alone, we are apparently driven unwillingly to acknowledge that additional complications must be

incorporated which will ensure that dangerous potentials will at all times be prevented, irrespective of the efficacy of earthing provisions.

In conclusion, I feel I am empressing the desire of all of us that Mr. Kinsman's paper is to initiate a movement towards the provision of suitable and effective means and regulations for adequately protecting all users of electricity from the dangers of ineffective earthing installations.

I feel that we should accord the author an acknowledgment of our appreciation of his bringing this subject to our notice, for I am sure that there are few of us who have not garnered some fresh concept on this problem which is rarely endowed with the importance it merits. (Applause).

ARMISTICE PAUSE.

At 11 a.m. members of the Convention observed the Armistice pause by standing silently for two minutes, after which the refreshment interval was taken.

On resuming at 11.20 a.m.:

Mr. Muller (Krugersdorp) : I would like to thank Mr. Kinsman for his very interesting paper on a subject of great interest and importance. Recently I have done a little experimental work in this direction, and I have come across an arrangement which I think meets the case fairly well. The only trouble is that you cannot get an earth switch with the overload at the same time. I have suggested to my colleagues that we use the overload breaker with an earth trip coil in place of cut-out fuses (Municipal). The installation would then be earthed in the usual way, but the earth trip coil is connected between the normal earthing system and a separate earth, the resistance of which need not be very low. The whole installation would therefore be tripped out should the main earth become unsafe. In this case you can still isolate in the normal way but you would

be safeguarded should your normal earth deteriorate. I would suggest that this question be taken up with the idea of getting a switch which combines overload with earth leakage. It should not be an expensive job.

Mr. W. C. Lindemann, Inspector of Factories (Engineering Department of Labour) : As a visitor and one who is deeply interested in the subject raised by Mr. Kinsman, with your permission I would like to acquaint you with some of my experiences relative to electrolytic corrosion which is mentioned in the paper. Before proceeding, I would like to remind Mr. Kinsman that according to electro-chemical authorities, some solutions are stated to act as partial rectifiers. Electrolytic action sets in irrespective of whether the vagabond or secondary currents in the earth are of an A.C. or D.C. character. As you are aware, my work is connected with safety first, which is governed by the Factory Act.

During the course of my duties and enquiries into the causes of electrical accodents and other similar occurances I am often faced with some peculiar electro-physical phenomena which are disclosed during the process of taking down evidence. For example, a passage of current traversing the body and travelling across the region of the heart usually produces fatal results.

Re the question raised by Mr. Rodwell of what constitutes a dangerous voltage, a fatal accident case on record disclosed a potential of 26 volts, damp conditions prevailing in an incline shaft of a mine.

As the time at my disposal is limited, I am only able to give members of this Association a brief account of an experience in connection with a certain cream cooler inside a large creamery situated in close proximity to the electrification system which gives one much food for thought. Picture a cream cooler composed of a parallel number of

2″ copper tubes, horizontally arranged, through which circulates a solution of brine. Externally and at right angles to the path of the brine cream is allowed to gravitate. "Galloping" corrosion occurred in the neighbourhood of where the tube ends are expanded and soldered into the upright headers of the cooler. The popular opinion experienced was that the electrolytic corrosion was caused by vagabond currents flowing and emanating from the electrification system. Bearing in mind that the rails are efficiently bonded this fact forces me to explore other possible causes. Much water is used in creameries, therefore the damp nature in the immediate neighbourhood may be looked upon as adequate direct earthing. However, to cut a long story short, it was decided to break up the brine circulating system by pumping the brine into a raised tank, the solution gravitating through the cooling system. An amazing result followed; the corrosion activity practically ceased and the expensive cooler could be used as an economic appliance.

This characteristic calls for an explanation, and brings me to another experience of mine in connection with steam generating plant in particular and which offers a reasonable solution to the problem in question. I find that when radiating heat cut across a system of water circulating tubes at right angles, a magnetic field is set up which arranges itself at right angles to the two planes of the radiating heat and circulating system. In fact this feature is slightly noticeable in cream coolers and other systems where two separated elements cross each other at right angles. Electrical engineers will at once perceive that this is an extension of the principle generally associated with the generation of electrical energy.

Now we all know that when a conductor in an electrical system is broken, current ceases to flow. Similarly, when the brine circulating system was broken by pumping the brine firstly into a raised tank and then allowing the solution to gravitate,

is on all fours with a disconnected conductor, and electrical energy ceases to exist, which in my opinion offers a reasonable explanation of why the electrolytic corrosion was checked without having to adopt special earthing arrangements.

In conclusion, Mr. President, I have to thank you for the privilege of allowing me to take part in the proceedings of this Convention. I also wish to congratulate Mr. Kinsman for giving us his most interesting and instructive paper, which brings to mind an apt quotation : "Electricians may come and electricians may go, but earthing will go on for ever." I thank you. (Applause).

Mr. Clinton (Salisbury) : I should like to express my admiration of Mr. Kinsman's paper, and the methods he used to illustrate the various points.

Although it has been held by conservative engineers that the present system of earthing is quite suitable to provide the necessary protection to the consumer, and those engaged in the electrical industry, there is, nevertheless, a considerable amount of uneasiness in the minds of thoughtful engineers regarding the suitability of present-day methods.

The opponents of any change in the methods of protection commonly used, usually maintain that accidents are comparatively few in number. Statistics in Great Britain are usually quoted to support this point It should, of course, be borne in mind that in doing so, one is comparing results of a country that is only to-day becoming electrically minded with particular reference to the domestic field. Even so, the number of fatalities due to electricity in Great Britain are on the increase. In 1912 there were 12, in 1926 there were 18, in 1932 there were 70, whilst last year there were 112. Is is similarly argued that the cost of the additional protection afforded by an earth leakage system is higher than is warranted, but I

think it would be conceded that the saving of only one life is worth a considerable outlay, particularly should that life mean the member of our particular families. It is certainly the responsibility of the electrical engineer to keep domestic installations as free from danger as science has made possible.

One point has been raised by Mr. Kinsman in the protection of domestic premises by the earth leakage system, and that is where he states it is necessary, in order to afford 100% protection, to provide a protective earth leakage switch on the service pole supplying the premises. Since it is to-day possible to purchase a switch for installation at the transforming point in the substation, full protection is possible up to the point of supply within the premises, from which point onwards an earth leakage switch controls the domestic installation.

For a considerable time I had doubt regarding the ability of the usual form of earth leakage switch operating coil to withstand the effects of lightning, particularly as the effects of lightning in Europe definitely held up the progress of this type of protection in Germany, due to the difficulties experienced in providing a sufficiently robust coil with the required sensitivity and minimum operating current.

Experience over the past four or five years in Salisbury on a limited number installed, confirms the subsequent experience in Germany, where it was found the modified robust coils now in use have proved entirely satisfactory.

On a further point raised by Mr. Kinsman in regard to the inability of the artificial earthing system to provide protection in the case of hairdressing establishments where electrical appliances are commonly used, I should like to refer to the use of a combined earth leakage protective switch and plug, which definitely provides a suitable pro-

tection to the user and to the person on whom the appliance is being used. This protection is obtained by means of a high resistance in the earth circuit, so reducing the possibility of dangerous currents.

In South Africa, where earth resistance in the drier portions of the country is usually high, excessive potentials in the vicinity of metal bodies, stay-rods, tubular standards and similar metallic structures embedded in the earth usually form a potential source of danger to human life and animals.

In this particular case, the only solutions on the horizon is an earth leakage on the lines of the principle set out in Mr. Kinsman's paper.

Whilst the danger which exists is usually compared in relation to the voltage. I should prefer to see reference to the maximum permissible current the human body can withstand on the average.

Some extremely interesting papers have been published by medical men having engineering experience on the effects of A.C. and D.C. currents on the human body. A study of these, forms a stimulating introduction to the principle of protecting human life.

In the field of rural distribution, the use of earth leakage switches should, I think, become compulsory at an early date. The pieneering efforts in Australia have apparently met with considerable success, for I understand the use of this type of protection is being rapidly extended.

In existing installations it may be difficult to persuade Councils to expend large sums on the replacement of existing fuse protection relying upon an earthed system, especially in face of the large amounts required by the average town for relief of the general rate. (Applause).

Mr. Pirie (Bloemfontein) : I wish to congratulate Mr. Kinsman uyon his most interesting paper, but in view of the limited time at our disposal I would suggest that during the next Convention at Capetown one morning be devoted to the continuation of this discussion. (Hear, hear).

The President : The Council will make a note of that.

Mr. Foden (East London) : I congratulate the author on his most interesting and valuable paper, the subject matter being of vital importance to Electrical Engineers involving as it does the precautions necessary to safeguard human life. Frequently this aspect of danger to life is unfortunately seized upon by our competitors in the field of power supply.

I would therefore welcome the author's comments upon the following notes regarding types of "earths."

When slight current leakages are present bubbles of hydrogen are formed thus increasing the earth resistance.

Taking advantage of this chemical change is it not advisable that when burying the earth plate a layer of carbon say in the form of sulphur free coke be placed on either side of the earth plate ? Due to the combination of oxygen and hydrogen moisture would be formed, tending to keep the surrounding soil moist and so reducing the earth resistance, carbon as we are aware being rich in oxygen.

Another method of providing an "earth" in districts with high soil resistivity is to take advantage of the top surface of the soil. A trench is dug 3-feet deep and in it is laid say 50 yards of 0·1 sq. in. sectional bare copper conductor. The conductor is surrounded with rock salt and the trench filled in with rubble to assist the passage

of moisture. Preference is here given to salt in place of coke due to the former eliminating the possibility of corrosion caused sometimes by certain qualities of coke and it is very questionable whether any sulphur free coke is commercially obtainable.

Would the author give his opinion on the advantage or disadvantage of the multiple earthing system as achieved in the following manner ? The neutral to be connected to earth at each disconnecting box or other suitable points of the distributing system, I would like to qualify these remarks by saying that this would only apply to A.C. systems as it is, I believe, safe to say that A.C. electrolysis is negligible, being less than 1% of that caused by D.C. current.

In conclusion I would say that in view of the valuable information given by the author on the earthing problem and the dangerous conditions which may arise, that the matter of adequate cross sectional area of the neutral link on consumers premises has been given serious consideration by the Committee compiling the Supply Regulations. I have in mind a section of link that would not be injured by a current of 100 amps. as a minimum. (Applause).

Mr. Milton (Electricity Supply Commission) : The question raised by Mr. Kinsman dealt with the matter of earthing in the draft Regulations. The Regulations in this connection are based on the I E.E. Regulations. Where it is impracticable to obtain an earth having a resistance of less than 1 ohm. the earth protection should be supplemented by earth leakage trips set to operate at not more than 30 milliamps. Under faulty conditions the voltage drop in the earth circuit should not exceed 50 volts, so I think all the requirements are taken care of in the regulations. For the benefit of those particularly interested in the subject I would like to mention a paper read recently before the Institute of Electrical Engineers in Johannesburg

which sets out the results of tests carried out in connection with the measurement of the resistance of the actual earth plates to ground. That paper should form a valuable reference for those interested.

The President : In view of the limited time at our disposal I propose to ask Mr. Kinsman to send his reply in writing to the Secretary for publication in the proceedings. (Hear, hear).

COMMUNICATED REPLY BY Mr. C. KINSMAN.

The question of the use of A.C. in measuring the earthing resistance of electrodes has been mentioned by Messrs. Rodwell and Lindemann. For the reasons mentioned by both these gentlemen, the figures in the paper in regard to the value of electrode resistances were measured with an instrument utilizing alternating current.

The danger of electrolysis arising from alternating current leakages was stated in the paper to be a very remote, if not non-existent possibility. Several authorities have stated that corrosion by this agency is only about one per cent of that caused by an equivalent direct current.

Mr. Rodwell has quoted some very intersting and convincing figures relating to the conductivity of standard cable sheaths. These figures tend to show the general inadequacy of a cable sheath as the return path for fault currents. This inadequacy is admitted, if the sheath were the sole return path, but the contact of the sheath with the cable armouring and the soil, supplements the sheath itself and provides a sufficiently low resistance path for fault currents.

In reply to Mr. Muller, switches combining thermal overload, magnetic overload and earth leakage protection are available although the author has not had any experience of such switches.

Mr. Clinton referred to the protection of a person, from the point of supply. This can be done by the installation of earth leakage switches at the substation. This system is being used on at least on the the German distribution schemes, but the interruption of the entire circuit from the substation will be brought about by a small leakage to earth in any installation connected to that circuit.

Mr. Clinton's reference to the voltage around a house or a standard on the occurrence of a fault directs attention to the question of "resistance areas" dealt with in the paper. This resistance area is that area in which an appreciable voltage gradient exists and is usually the area within six to ten feet from the charged metal body.

Mr. Foden has raised one or two interesting points regarding the method of installation of electrodes. Whilst in agreement with him on the possibility of sulphur in coke causing corrosion of the electrode, I would point out that such corrosion, causing as it does an impregnation of the surrounding soil with particles of the decomposed metal, will in effect increase the area of the effective electrode and so improve its efficacy. This statement of course must be qualified by the reservation that the corrosion is not sufficiently severe to corrode the electrode away completely. The use of a length of copper conductor in the manner described by Mr. Foden will be very satisfactory as is borne out by the figures quoted in the paper as representing the earthing resistance of a copper strip buried longitudinally in the ground.

The President : I now call upon Mr. Muller to read extracts from his paper "The Administration of Smaller Municipal Undertakings."

The Administration of Smaller Municipal Electricity Undertakings.

Touching upon Financing, Tariffs and Production costs per Unit Sold.

by H. M. S. Muller,
Town Engineer — Upington.

With the present greater, wider and more general use of Electricity in the Home and for Industries, it is difficult to forecast the requirements for even the next ten years. It is, however, clear that with the present rate of astounding progress the utmost resources of the Engineer will be taxed to bring about greater efficiency and generally to lower production costs per Unit sold to the Consumer.

It is not a matter of finding the Consumer, but purely a question of whether the Consumer can be met on a competitive basis for lighting, heating or power. Lighting has long since become an accomplished fact in practically all the Towns in the Union and costs the Consumer no more than the infinitely less 'candle power' illumination of erstwhile methods, but the greatest and urgently necessary development awaits, on a competitive basis, for heating and power.

While there are great Power Undertakings in South Africa that compare favourably with similar Undertakings in other parts of the World, ranking as the lowest in production costs per Unit sold, it cannot be gainsaid that, taking Municipal Supply Undertakings in South Africa as a whole, the position is only now emerging from

what practically amounts to a state of chaos, in the diversity of conditions and varying production costs per unit sold. By no means the least of the several contributing causes of this state of affairs, is the manner in which some of these Undertakings are administered.

In this respect, it must be realized that in South Africa the annual Municipal expenditure amounts to millions of pounds. Such expenditure naturally has a considerable effect on the general business throughout the Country, as well as affecting, both directly and indirectly, the welfare of millions of people.

It must further be realized that, whereas a brief ten or fifteen years ago the average Municipal expenditure of Country Towns throughout the Union hardly amounted to £2,000 per annum, some £10,000 or more would be the figure to-day. Therefore, methods that were good enough ten years ago require very serious revision to-day.

Surely the time has now arrived when Municipal Administration should be considered in the light of National importance.

We can digress a little and dispassionately consider the elegibility (or otherwise) of men serving on Municipal Councils, which have control of such Undertakings, but are not sufficiently restricted by Legislation to adhere to a definite system of Financing.

The subject, therefore, is the Town Councillor, whose position (to the conscientious man) is never enviable, and is most frequently a very thankless one. However, in the light of what has been stated, it certainly is, and ought to be, one of the most worthy and responsible positions in Civic life. It requires men of integrity, men who are broad-minded and competent, and who, above all, have a wholesome understanding of the true function of a Councillor.

The progress, in every sense of the word, of the Town and the community devolves upon the ability of the Council to follow and to anticipate the general progress of the Country, and, above all, to preserve, in as far as the human element will permit confidence and harmony among Council, Rate-payers and Employees.

Even in the smallest communities there are sufficient men of the right calibre, but it is a fact that in the same Town or Village, other public bodies such as School Boards, Hospital Boards, etc, are frequently represented by more men of broad outlook, ability and general knowledge, because that type of man usually follows a profession, trade or occupation which renders him ineligible as a Councillor, or his seat on the Council would prejudice his business interests, hence Municipal honours only too frequently demand heavy sacrifice and are not much sought after by such men.

The question arises : Is the Councillor competent to direct vital matters of Management by virtue of three years of office, without the assistance of set rules? Alternatively, it is frequently found that Councillors remain in office for more than fifteen consecutive years. This certainly has its advantages, but can at best be regarded as a mixed blessing.

Under prevailing conditions, is it not apparent that where such large issues are involved, affecting the Country as a whole, stability and greater progress will be the immediate result, if Municipal Administration is subservient to more set rules, especially in the matter of Light and Water Undertakings?

No doubt for years to come each such Undertaking will still remain an isolated case, influenced by peculiar local conditions and there seems to be little immediate prospect of any measure of uniformity.

Considering Electricity Supply Undertakings, there are still too many with a total capacity of 200 k.W. and under, which are comparatively over capitalized, and the position is further aggravated by the comparatively high railage on fuel. In view of this, hardly any two such Schemes can be administered alike — but correct financing and general expansion to keep pace with rising demands, are matters which are common to all.

In proportion to their assets or rateable value, the Undertakings of Villages are no less important than those of the Cities. They all form part of a whole, which cannot afford to overlook the great advantages of interchange of ideas and a concerted movement with the object of constant development.

It is for Municipal bodies to display a greater interest in, and to take advantage of the fine work done by the A.M.E.U. and to support such movements as the E.D.A. and others affecting such public and essential services as they have under their control. With wholehearted co-operation and healthy understanding, definite and mutually protective Legislation can be brought to bear on many vexed problems that are at present dealt with in a haphazard manner.

To suggest definite control by Legislation means no restriction on the moral right of freedom of action within your 'own home' but merely an honest admission of the fact, that none of the qualifications required by Law, which a prospective Candidate for Municipal honours must possess, even remotely affect the competence of such a Councillor to assist or influence any course of action, contrary to sound and accepted practice in the Administration of such Supply Undertakings.

On the other hand, the Engineer in charge of such Undertakings in the smaller towns is frequently a lowly paid man of insufficient experience or even qualifications to take the lead, and is

virtually what he is generally regarded as by the Public at large, namely an Electrician or Mechanic who keeps the running Plant in order for the production of Electricity and to ensure a continuous water service. Even if he is a man who is sufficiently qualified and experienced and can direct the general development and financial side of the Undertaking, he is still altogether without authority, and more often than not, his advice is not taken, because it is easier to give way to the urge of the present position and leave the future to others.

It has been said to the writer by the best Authority in the Country, that whenever a Scheme has failed to be self supporting after a reasonable period, the cause, or causes therof could be traced to the fact that the advice of the Engineer in charge was not taken. This is certainly overstating the case, but we are all acquainted with the function of the Electricity Supply Commission as affecting Municipal Electrical Undertakings, and its invaluable service to the country. I have no doubt that most of the Engineers in charge of the smaller schemes at least, will agree with me, that it is equally essential that the powers vested in that body should not cease with the final approval of a scheme, but extend to a ruling on points affecting the subsequent management.

There have been instances where it at first appeared that a mere village would not be able to support an apparently over ambitious scheme, yet such a scheme readily became self supporting, for the necessary load was found, where a sufficiently competitive Tariff could be extended.

The condition of such Undertakings as are virtually over capitalized and in a state of semi-stagnation, can readily be traced to the actual causes and not to a want of a better load curve, especially in this era of Electrical development.

Every Undertaking should annually contribute from its Revenue a certain percentage as a "Renewal" or Development Fund and should clearly shew in its estimates what amount of such funds is to be spent during the year. The alternative and slip shod method of spending considerable sums from Revenue on extensions, etc., of a purely "Capital" nature, as the occasion arises, is deplorable and will continue as long as the Local Authority is not compelled to remain strictly within the estimates.

You cannot for a moment consider it justified to make Distribution extensions running into two to four hundred pounds from Revenue, if for years to come the total Revenue derived from that portion of the Distribution will be from £5 to £15 per annum. If this is put up as part of the scheme it would be turned down.

At the last Convention it was shewn that very heavy and destructive indirect taxation could be imposed on smaller Undertakings, in the form of low charges for Street lighting or other Municipal services; also free and unrecorded services. To this one could add Town Office salary levies incommensurate with services rendered, etc. Then there is, of course, the burning question of how much, if any, of the profits of an Undertaking should be converted to the relief of General Rates.

Considering the Municipal services, such as Street lighting and power for water pumping, these should be correctly debited on an equitable basis to General Account and to Water Works and a corresponding credit passed to Light account; but apparently the Local Authority can consistently ignore the claim and even delete it from the balance sheets or estimates. Alternatively, it would appear that where £400 or £500 would be an equitable amount, £40 or £50 can be considered as equitable without fear of contradiction, nor is it encumbent on the Local Authority to

record the loss in the balance sheets of the Department giving such service below production costs, or free.

Apparently the allocation of salaries can be treated in the same way when deciding upon the correct proportions to be allocated to the different Departments.

As an example of these practices, take the case of a small Undertaking of say, 200 k.W. capacity and selling 300,000 units per annum, with approximately 282 Customers (two bulk supplies) and a corresponding Revenue of £5,500. The units sold, being accounted for as follows :—

	Consumption.	Revenue.
Bulk supply consumer. Maximum demand 25 k.W.	56,000 units.	£1,000
Municipal Water Pumping and Municipal Street Lights— Maximum demand 40 k.W. ..	94,000 units.	£1,200
	150,000 units.	£2200

This leaves some 280 Consumers with a maximum demand of 40 k.W. to account for 150,000 units at a revenue of £3,300 or 5.28 pence per unit.

Considering the conditions of service and the maximum demand, the revenue from the Municipal services should at the least have been £700 more.

Add to this an amount of £280 as Capital Expenditure from Revenue and £120 as an excessive allocation to Municipal office salaries from the Electricity Department, and we get a sum of £1,100 excessive levy on 280 consumers or practically £4 per annum per consumer, or 1.76 pence per unit. Compare this with the fractional levies of the larger Undertaking.

Subtracting this from the average price for all classes of the 280 consumers, of 5.28 pence per unit, we get 3.52 pence per unit, which is already

a high average price, without the additional imposition of 1.76 pence per unit.

For the purposes of domestic lighting, refrigeration and cooking, an average price per unit of 2½ pence is a long way from being competitive and should be nearer 2.05 pence or lower, to meet the prevailing conditions in the smaller Towns. Is it necessary to point out that the Engineer in charge, has no hope of building up a 'domestic' day load where such strangling levies are imposed, although the actual production costs per unit are low enough?

Very much has been said and written about the direct methods of taxation levied on Electricity Undertakings and the writer does not propose to enter into this controversy, apart from saying that its misuse is a parasitic and malignant growth on the Electrical Industry.

Without proper control, it is a demoralizing source of replenishment for careless administration, robbed of that finer judgment that must be exercised in the presence of a definite income. However, the slip shod and unqualified administration that lends itself to the peculiar form of indirect taxation stated in the foregoing, is even worse, because it is not a fractional levy per unit, which may be levied for the good of the Municipality as a whole but is virtually unrestricted to the extent or ruining an otherwise sound Undertaking.

Taking the whole matter from another point of view, then it cannot be denied that the application of Electricity to our daily use is of vital importance and that the time has arrived where of necessity Electric lighting, heating and power is superseding all the erstwhile methods in Towns having a white population of 3,000 and more. Before this period, it would have been equally consistent to empower the Local Authority to levy

a tax (for the relief of General Rates) on every cord of wood, bag of coal, gallon of paraffin or packet of candles the housewife bought!

Before exception is taken to these statements, it must be considered that these matters have actually seriously influenced the success of Undertakings and should be considered dispassionately in all their aspects, in order to ensure future stability and progress.

There is also the point of view of the Engineer, who, if he is a man worthy of his calling, cannot be satisfied with supplying a modern essential service at a cost which makes it a luxury, when his whole career is one of comparisons, and a striving for a competitive money saving basis. If it cannot be reduced to £. s. d. then at least, the service so given must directly or indirectly prove its benefits equally to the whole community to justify its existence.

It has been said that many of these smaller Undertakings will still remain isolated cases, where each has to be administered according to peculiar local conditions.

Usually the staff consists of the Engineer in charge, three Shiftmen and perhaps two Apprentices or an Improver. Many of these Undertakings employ Shiftmen for as low a figure as £8 per month and there are instances where less is paid. Apart from the false economy of such proceedure and the consequent short 'life' of the Plant, it will be obvious that the knowledge is all centred in the Engineer in charge. In the circumstances a change of Engineers is a very serious matter to the small Undertakings, although this is rarely given a thought and only the Engineers themselves realize what the temporary and indirect losses will be, until the successor has taken up duties and reorganized the works.

These changes are all too frequent on account of the insecurity of Municipal employment. The annual Election may bring changes of salaries and

working hours. Incidentally, to the writer's knowledge the only limit to Municipal working hours is that of the Mines and Works Act which restricts a Shiftman's attendance on running machinery, to 10 hours per day, except in emergency.

With different Municipalities, the writer has often had to draw attention to this regulation to prevent the dismissal of one of three Shiftmen, in order that the remaining two should each work an eighty four hour week at the same rate of remuneration. It is the general practice to run 12 or 16 hour shifts during annual leave or illness of any members of the staff.

Referring to these Undertakings, it is the experience of every Engineer in charge that, when the periodical Election disturbances take place, and it is proposed either to reduce the number of the staff or the rate of remuneration, then inquiries are sent to other Municipalities to find what the number of their staff is and the rate of remuneration, irrespective of whether the annual output may be a million or twenty thousand units.

It must be understood and realized that all these matters lead to confusion, inefficiency and serious loss that no private Industry could incur without disaster, but the Municipality can control its Tariff to meet its expenditure and if maintenance charges are unreasonably high or the life of the Plant is much too short, due to incompetence or mismanagement, the Consumer or even the Ratepayer is called upon to foot the bill. Naturally this leads to overcapitalization or at best, to high production costs per unit sold—and that in this era of Electrical development, when a fractional reduction in the price per unit sold, is the difference between progress or stagnation.

Considering Undertakings which give 24 hours service and generate from 100,000 to 500,000 Units per annum, the staff should consist of the En-

gineer in charge, three Shiftmen, a fitter who is also a relieveing Shiftman and general assistant to the Engineer and an Improver—generally an Apprentice as well. With this staff very little indeed need be done by the Town Office in the way of clerical work. It will actually be found that most of these Undertakings include the management of the Waterworks as well with no addition to the staff apart from native labour. For smaller concerns the Station Fitter is about the only one that can reasonably be dispensed with.

The writer has for many years and with two different Municipalities held the dual office of Town and Electrical Engineer in control of the Light and Water Supply Undertakings, with a staff which at no time consisted of more than a Senior (Fitter) Station Engineer who takes a regular shift, two Shiftmen and an Apprentice, with the addition of a Pump Attendant for the Water works. The units sold annually being from 200,000 to 300,000 and the water from 30 to 45 million gallons.

The work embraces all the necessary extensions and service connections of either Department in addition to the usual work, and the Meter reading and the making out and delivery of all accounts whatsoever, as well as attending to all correspondence, etc., etc.

It is very unusual for the Engineer to attend to the monthly accounts, but its advantages are apparent. It centres the work in one place and errors are reduced to a minimum. Above all, it keeps the Engineer in close touch with every Consumer and precludes all those annoying little complaints, which usually leave the Consumer dissatisfied and under the impression that there is general negligence and inefficiency.

Incidentally, the reading of 300 each of Light and Water Meters is usually begun by the 28th of the month and all the accounts are delivered by

hand not later than the 2nd of the month following. This work is done solely by the writer and an Apprentice—even the delivery. Bearing in mind that this involves some 600 Consumers and as many accounts, I doubt if this as a regular practice has been or can be, improved on. Actually the work is done in the space of four working days—working to a definite system which practically eliminates error and is certainly the cheapest of all methods covering every requirement for such Undertaking.

If any of the Engineers are interested, the system is readily explained and the information will gladly be given.

There is little to be said on the general financing of these schemes as it is under the best possible control when a scheme is submitted for approval. However, it is apparent that the success of the scheme largely depends upon the cost per k.W. installed. This is always the greatest figure in the cost per unit generated or sold. Once the load on the plant has reached its maximum capacity, this figure remains unalterable. The writer considers that for all practical purposes the installed cost per k.W. should be arrived at by considering what is the reasonable maximum peak load that the Station can consistently carry, and not from the actual number of k.W. installed, which does not reflect up the probable annual output.

Drawing on past experience it would appear, that especially where internal combustion Engines are installed as prime movers the Loan redemption period should not exceed 20 years, especially in the absence of a compulsory 'Renewals' Fund. Without the Generating Plant the Distribution is no asset and usually, long before the redemption figures become significant, the scrapping of the Generating Plant is considered.

A short redemption period will naturally increase the fixed 'capital charges' per unit generated or sold, but if it can be shewn that the

scheme is able to operate on a normal Tariff in spite of this, then it commences on a sound foundation. There is no way of side-tracking the annual Interest and Redemption, whereas, there is usually nothing left at the end of the year, to set aside for Renewals. When the inevitable scrapping of the 'old Power Station' takes place, a sufficient amount of the original Loan will have been redeemed on a short redemption period, to compensate for this, but it is usually found that the new scheme must carry the additional burden of the capital cost of the original generating Plant and buildings.

From the Engineers' point of view, it is easy to frame tariffs that will cover the different conditions governing the costs per unit generated or sold, but such tariffs will be entirely scientific and will not be acceptable to the Consumer, therefore the only course is to compromise. That is, to frame a kind of two part tariff. The first part must definitely protect the Undertaking from loss. This must in some way be connected with the fixed or standing costs, as derived from the annual costs in respect of the Capital expenditure on the scheme. It should further be connected in some way with the Consumer's maximum demand on the Power Station. Within limits the tariffs must be as few as possible and in as far as possible, must be simple enough to be understood by the average Consumer.

The usual sliding scale tariff which takes the form of 'x units at 1/- per unit, x units at 6d. per unt, x units at 3d. and all the rest at 1d. per unit,' was readily understood and accepted by the consumer. Even then, it was asked 'why can't I pay all one price per unit and why must I buy so much before I can get a reduction?' However all appreciated the old commercial principle of 'the more you buy, the cheaper you can get it for.' When we introduce new tariffs, we must still trade on this to induce the consumer to be reconciled to the new order of things until its bene

fits can be appreciated, even if it is never really understood by the majority of consumers and remains a source of grave suspicion.

Of this two part tariff, the second part may be a flat rate per unit, or a compromise of the above defined tariff. That is, a part sliding scale price per unit and is so arranged that the variable costs per unit sold (up to a certain number of units consistent with the Consumer's demand on the Power Station) is well covered by the average charges per unit for this number. All the units taken in excess of this amount, can then be charged for at a fraction more than the fuel and oil costs per unit sold.

While this may be simple enough, it must be fairly admitted that its application to Domestic consumers, requires careful consideration.

It is obvious that even with the identical appliances installed in different houses, a family of four will not require as many units as a family of eight. Close observation will also prove that although the identical appliances are installed, the actual average demand on the source of supply at peak load, will actually be greater for the larger family and to all practical purposes in proportion to the monthly consumption in units as against that of the smaller family. Moveover, it will possibly be found that even up to a family of five, the total loading of the required cooker will be lower than that for a larger family.

The maximum requirements (water heating excepted) of the family of four will be round about 350 units per month and that of the family of eight would hardly be less than 500 units. No doubt in flats which only two or three people occupy, the monthly consumption is less than 350 units. Now in view of what has been stated with regard to the loading and corresponding monthly consumption, it is manifestly unfair that the smaller consumer should pay a higher average

price for all units consumed than the larger consumer. In proportion, they share equally in the Municipal debt, and again in proportion, the smaller consumer is equally valuable to the Undertaking. The difference in cost of the service connections, if any, is not significant and it is merely a question whether each class of Consumer is taking all the units (possibly required) and in the same proportion to the diversified Kilowatt demand from the source of supply.

Apparently the two forms of 'two part' tariffs most in use for Domestic use is the property valuation and 'living room' basis charge. The former presents too many difficulties to be equitable. In the first place, two dwellings, both of six living rooms, can occuply vastly different areas and site values differ vastly. The owner of the higher valued property already pays his rates in proportion. It is clearly wrong to tax the owner or occupier with an 'Electrical' tax that has little bearing on the conditions of consumption.

The 'living room basis' whilst not ideal, is decidedly more equitable. It may be argued that the 'living room' basis also has too many weak points and that for all practical purposes, the great majority of domestic Consumers can be based on a diversified demand of 1¼ k.W. (for all Electric houses), and that it is not worth while to discriminate between a demand of ¾ and 1¼ k.W. This will hold good for the Cities and large Towns where the average cost per unit is very low, but not in the small Towns where of necessity, the first 60 to 100 units may average 4d. per unit and even more, before the Consumer can come on the low rate of 1d. per unit or thereabout. Assuming that the 'living room' first part charge is adopted, it will be found that the number of living rooms at the same price per month per living room (covering so many units) to all classes of Consumers does not automatically adjust the average price per unit that each class of Consumer will pay when making the same full use of their

appliances within their requirements. It is therefor necessary to make a further adjustment in the second part of the two part tariff. That is, for example — for five or less 'living roomed' houses the first 70 units should be high rate units, while for six to ten 'living rooms' the first 100 units should be high rate units. All thereafter to each, is a flat rate. In this way, every class of the same type of Consumer taking the supply under the same conditions, will be paying as near as possible the same average price per unit, when the number of units consumed is divided into the sum of the account.

It is with diffidence that the writer submits the following Tariffs, which in his humble opinion meet all the different classes of consumers in the smaller Towns on an equitable basis and is also within the means of every Supply Undertaking. Naturally it is subject to modifications and alterations to meet Local conditions and can no doubt be greatly simplified and improved on by more experienced Engineers.

SEPARATE METER TARIFFS.

Lighting : A monthly minimum charge of 6/6d. covering the first 6 units, whether the consumption equals this amount or not; then 1/- per unit for the next 50 units and all in excess of 56 units, 9 pence per unit.

Day Power : (between sunrise and sunset only) : a basis charge of 3/- per month per horse power installed, or part thereof and 3 pence per unit for all current consumed up to 200 units. Thereafter 2 pence per unit.

Through Power Service (unrestricted) : For Bioscope projectors, heating, cooking, etc., a basis charge of 5/- per month per horse power installed or part thereof, 3½ pence per unit for all current consumed.

The monthly minimum charge is 6/6d. for such power connections whether the consumption equals this amount or not.

Combined Light and Power Service through one Meter.

(A) **Combined service :** For all private dwellings, boarding houses, hostels and hotels having 5 living rooms or less (provided that less than 3 shall be taken as 3) a basis of 3/- per month per living room, covering 3 units per living room. Thereafter 50 units at 3 pence per unit, provided that the number of units covered by the basis charge, shall be deducted from such number of units at 3 pence per unit, then 24 units at 2 pence per unit and thereafter 1d. per unit.

The monthly minimum charge for 4 or less rooms is 12/- and for 5 rooms is 15/- whether the consumption equals this amount or not.

(B) For 6 to 10 living rooms, also as above, except that the first 80 units are at 3 pence, the next 36 units at 2 pence and thereafter 1d. per unit.

(C) For more than 10 living rooms the tariff is similar, except that the first 400 units are at 3 pence per unit, the next 240 at 2 pence and thereafter 1d. per unit. For (B) and (C) the monthly minimum is in accordance with the number of living rooms at 3/- per living room, whether the 3 units covered by each room has been consumed or not.

(D) **Combined service :** For all Cafes, shops, stores, offices, halls, garages, etc., a basis charge of 4/- per month per room, covering 3 units per room. Thereafter 150 units at 3 pence per unit, provided that the number of units covered by the basis charge shall be deducted from the number of units at 3 pence per unit. Then 100 units at 2 pence per unit and thereafter 1d. per unit.

For the purpose of tariff (D), room means every 300 sq. ft. of floor area. The minimum floor area shall be taken as two rooms and the maximum as 7 rooms. The monthly minimum charges shall be in accordance with the number of rooms, whether the 3 units covered by each room has been consumed or not.

It will be noted that in this tariff the monthly minimum charge will be 8/-, even if the floor area is less than 600 sq. ft. Should it exceed 7 rooms or 2,100 sq. ft., the maximum basis charge is 28/-.

(E) **Night Power :** 11.30 p.m. to 5.30 a.m. (restricted by time switch). A basis charge of 2/- per month per every 1,000 watt installed loading or part thereof in excess of 300 watts and 1d. per unit for all current consumed.

Premises becoming temporarily vacant or partly vacant, and where the supply has to remain uninterruped under either of the tariffs A, B, C or D, can operate for the time being on a flat rate of 2/- per unit with a minimum payment of 8/- for that month during which all, or most of the occupants were absent.

The foregoing gives an outline of the tariffs in use, which, with certain alterations to suit each small town, shown in the writer's opinion, amply cover the requirements on an equitable basis, of the various types of consumers in such towns.

Comparing the first three usually accepted tariffs for separately metered supplies with that of the following combined supplies, actual application will shew that they do not clash and that consumers operating on the first three tariffs, have every inducement to adopt the combined tariffs. In fact, in practice most Lighting consumers having a wireless set as well, find it to their advantage to go on the combined tariffs.

Once the combined tariffs are introduced, it will be found that the first three will rapidly fall into disuse and can eventually be eliminated entirely, without getting the consumer up in arms.

The next step is to change the combined tariffs from time to time as the Undertaking progresses, such as eliminating the 2d. per unit rate, covering more units per room and finally reducing the 1d. rate.

It has been very difficult to obtain accurate figures from other towns but the following gives

a close average of the annual output per k.W. demand, from the different classes of Consumer :

Muncpl. Service.	Bulk Supplies.	St. Lighting.	Pvte. & Other.
3,400 Units.	1,800 Units.	1,200 Units.	2,800 Units.

Stoves are not included for the 'private and other', but includes a refrigerator, vacuum cleaner and other small appliances for one out of every 6 consumers. Only this small percentage of refrigerators, etc., makes a startling difference to the well known figure of 144 units per annum per consumer of a few years ago as against 400 units per annum per consumer under the above conditions.

At the last Convention the average allowance per (lighting) consumer was given as ¼ k.W. It was also shewn that although the total loading of stoves would average some 6,000 watts each, the actual diversified demand was not more than 1 k.W. From this, it would appear that you could not be far wrong in taking the all Electric house (water heating excepted) at 1¼ k.W. demand. The writer has consistently found that the first figure of ¼ k.W. is given too high and is less than 1/6th k.W.

It will therefore be seen that with a stove installed, this type of consumer with an annual consumption of 3,650 units, is comparatively the best consumer.

With regard to the larger or Bulk supply consumer, the tariff is usually a two part tariff which takes the form of a primary k.W. or k.V.A. maximum demand charge, which covers the Undertaking against loss in making up the standing costs in respect of Capital Expenditure, plus the second or unit charge, which as stated in the foregoing, affects the variable costs per unit generated or sold—such as fuel, wages, oil, water, maintenance and stores.

In computing the k.W. or k.V.A. basis charge, the writer is of opinion that the continuous and effective load carrying capacity of the Station should be considered and not the total installed k.W. capacity, as already stated in the foregoing.

The writer and no doubt some of the Engineers in charge of the smaller Undertakings, will welcome some discussion on Bulk supply tariffs, and also an indication as to what can be considered a fair annual minimum output per k.W. demand in order to decide on the minimum charge per annum. Usually, the primary k.W. or k.V.A. basis charge cannot be set high enough to cover all the requirements of the second part of the tariff.

Appended are some interesting figures for comparison, of the working costs and average price per unit sold in towns in the Union and Rhodesia. Also an example of how the total cost per unit sold is usually made up under the different headings.

In conclusion the writer must state that he is fully aware that the object of preparing a Paper that will be understood, and that will be of interest to Councillor Members and that will provide discussion for all, has not been achieved with any degree of success. Moreover, with the best intentions, the writer found it impossible to devote sufficient time and thought thereto. It may also appear that the writer has been too outspoken in parts, or inclined to emit grievances. This was certainly not intended. The writer has merely stated facts that will be supported by Engineers and Councillors alike; nor has such statements been made without serious forethought, but in the sincere belief that useful and constructive discussion will arise therefrom, affecting matters of vital importance that have hitherto been overlooked.

APPENDIX.

Example : Assume a Power Station of 200 k.W. capacity with an annual output of 240,000 Units Sold, and assume that the total Capital Expenditure is £20,000 for the whole Undertaking and that the total annual Working Expenses amount to £4,500. Then, taking everything in round figures, the costs per Unit Sold under the different headings will be approximately as follows :—

ITEM :	£ s. d.	£ s. d.	Unit Sold Per Pence
GENERATION :			
Fuel	1,000 0 0		1·00
Oil, Stores, Water, Etc.	200 0 0		·20
Repairs, Maintenance, Renewals	150 0 0		·15
Salaries and Wages ..	850 0 0		·85
		2,200 0 0	2·20
DISTRIBUTION :			
Meters and Consumer's premises	150 0 0		·15
Mains, Maintenance and Street Lamps ..	100 0 0		·10
Salaries and wages ..	50 0 0		·05
		300 0 0	.30
MANAGEMENT, ETC. :			
Salaries—Engineer and Town Office	600 0 0		·60
Audit, Insurance and all other Office expenses	200 0 0		·20
		800 0 0	·80
CAPITAL EXPENSES :			
Interest and Redemption on £20,000 Loan ..	1,200 0 0		1.20
		1.200 0 0	
TOTALS for 240,000 Units sold		£4,500 0 0	4.5d.

With a total capacity of 200 k.W. as given in the above example, such a Power Station can readily cope with an additional output of 150 000 Units per annum, and if the scheme has a sound Distribution, it is all a question of a good 'Load Factor.' The only additional expense to send out another 150,000 Units per annum, is reflected in the first item, namely Fuel. With an improved Load Factor the penny per Unit Sold for Fuel, will most likely drop to 0.75 pence on the additional output of 150,000 Units. The second and third items can be considered but are hardly significant and the drop in fuel consumption will more than cover the small additions to these items.

From this it will be seen that the additional 150,000 units can actually be sold at a profit at one penny per unit, as salaries and wages under Generation will remain the same and also the total amounts under Distribution, Management and Capital Expenses.

A certain amount of expense may be incurred with the installation of Stoves, but this is usually separately financed and the consumer usually bears the cost of service connections. It only remains to devise an equitable Tariff ,that will give each type of Consumer a proportionate share in the 150,000 low rate units, after each has contributed (in proportion to the horse power demand) in the primary high rate units, averaging 4·5 pence per unit in working expenses.

Comparative figures of total working costs per unit sold, where the output exceeds 200,000 units sold and is under one million units, 'Hydro' Stations excepted.

	TOWN :		White Population :	Units Sold :	REVENUE :	Pence per Unit sold : Working Cost:	Revenue	Fuel (Ton 2,000 Tbs.)	
1.	Umtata	W.O.	2,700	873,928	£7,184	1·972	1·972		
2.	Carolina	S.O.	2,029	282,433	2,283	2·1	1·939	6/6	
3.	Standerton	S.	2,290	880,173	7,603	2·170	2·072	13/3	
4.	Ficksburg	S.	2,503	656,200	7,303	3·23	2·671	17/3	
5.	Frankfort	W.S.	1,500	366,500	4,395	2·4	2·878	13/9	
6.	Cradock	S.	4,000	988,759	11,383	2·6	2·762	20/9	
7.	Volksrust	S.	2,961	689,630	8,539	2·66	2·971	12/5	
8.	Gwelo	S.	1,500	994,811	12,360	2·79	2·981	22/-	
9.	Vryheid	S.	3,122	816,265	9,371	2·751	2·749	7/3	
10.	Wellington	W.O.	2,926	467,937	6,721	2·8	3·499		
11.	Mafeking	S.	2,300	816,862	10,622	2·827	3·12	16/8	
12.	Mosselbay	S.	2,865	830,369	10,238	2·9	2·959	26/-	
13.	Upington	S.	2,400	250,000	4,800	3·33	4·608	28/-	
14.	Gatooma	S.O.	750	351,752	5,340	3·39	3,643		
12.	Mossel Bay	S.	1,350	282,939	3,935	3·4	3·339	13/-	
16.	George	O.	5,547	510,864	8,308	3·5	3·903	162/-	Oil.
17.	Rustenburg	S.	3,132	429,105	7,748	3·56	4·334	14/5	
18.	Livingstone	S.	860	748,943	12,356	3·6	3·967	4/6	Wood.
19.	Robertson	S.	3,141	555,279	9,387	3·7	4·057	24/4	
20.	Windhoek	S.O.	4,760	970,370	15,163	3·81	3·75	53/6	
21.	Barberton	O.	1,800	290,000	4,043	4·1	3·347		
22.	Eshowe	O.	786	225,770	4,074	4·261	4·33	121/5	Oil.
23.	Graaff Reinet	S.	4,436	369,028	6,581	4·28	3·902	21/8	
24.	Middelburg	S.	2,092	381,950	7,256	4·3	4·559		
25.	Senekal	G.O.	1,850	280,948	6,254	4·33	5·342		
26.	Caledon	O.	1,853	212,822	4,464	4·5	5·034		
27.	Ermelo	S.	2,700	321,013	6,052	4·6	4·524	3/6	
28.	Vrede	S.	1,680	251,912	4,663	4·78	4·442	15/6	
29.	Oudtshoorn	S.	5,630	700,840	12,723	4·8	4·356	26/3	
30.	Greytown	S.	1,138	226,723	4,705	4·85	4·98	5/6	Wood.
31.	Beaufort W.	G.	3,180	326,889	7,081	4·86	5·198	36/11	
32.	Ladybrand	G.S.	2,297	320,000	5,290	4·9	3·967	30/2	
33.	Kokstad	O.	1,433	225,600	5,294	5·4	5·631	152/6	Oil.

Figures taken from the Municipal Year Book 1936-1937.

S. = Steam: G. = Gas: O. = Oil: W. = Water.

The President : We must thank Mr. Muller for his very interesting paper which is now open for discussion, and I would like all comments to be as brief as possible in view of the little time left us.

Mr. Sparks (Pietersburg) : I would like to thank Mr. Muller for his very useful paper. This is not the first time he has come forward to give us his views. There are one or two points, however, with which I do not agree. My experience is that the less an electrical engineer is tied up to one spot the better it is for the concern. There is also a marked divergence of opinion in regard to the electrical engineer dealing with the accounts. One principle we have to be guided by is that the higher your initial tariff the lower the cheap rate can be, and I think it is wise policy to keep the initial tariff very high. Mr. Muller is both electrical engineer and town engineer of Upington, and my experience is that in that position you must lean to one side or the other. It is absolutely essential that when a place grows the two positions should be separated so that the electrical engineer can devote his time to producing good results.

Councillor Wright (George) : I must admit to a sense of shame that Electrical Engineers find it necessary to pass strictures upon the actions of Councils, more particularly where, as in this case, I feel they are largely justified. I have been a member of our Town Council for a little more than one year and I confess that it is a most unsatisfactory state of affairs to find that our Undertaking is burdened with only partly re-paid loans covering in some cases non-existent plant and also obsolete plant, not to mention plant recently purchased and already superseded that will have to be sold at less than half price.

With all this burden of debt, it will be some considerable time before we will be in a position to cover our expenditure by revenue.

I have been a commercial man all my life and I submit it would be impracticable to run a private Undertaking on these lines. All Municipal Accounts are under the close supervision of the Provincial Audit Department and I contend it is the duty of that Department to see that adequate allowance is made for obsolescence and depreciation. If this duty was properly carried out, the present situation could never have arisen, or certainly not to the extent of which you so justly complain.

It is a matter of Accountancy and the Audit Department should set the position squarely before the Councils and the Ratepayers, so that the full financial implications of an Undertaking be revealed. Were that done invariably, the present unsatisfactory state of affairs would not arise. (Applause).

Mr. Muller (Krugersdorp) : I thank my namesake for his very interesting paper. After listening to Mr. Sparks I am constrained to remark: "Et tu Brutus!" (Ltr). He reminded me that when we had our estimates placed on a new basis our cover was the colour of salmon pink, and ever since then we have been known as the "fishy" department (Ltr.)

On the question of spending profits on Capital extensions, I cannot see that that is such a tremendous sin. Personally I would rather spend the money upon laying down a line than upon putting down curbing and channelling.

Mr. Milton (Electricity Supply Commission) : It was very pleasing to hear Mr. Muller refer to the necessity for adhering to the advice given from time to time. Before going further with that, I would like to express my agreement with Mr. Muller in his inference that the political aspect of extensions, etc, plays a far greater part in decisions than the actual economics of the case.

Our Councillor friend from George has waxed very warm on this subject, and I must say I cannot blame him. It would appear, however, that he has not a full knowledge even now of what goes on. Advice is being given to Municipalities from time to time, and that advice is being completely ignored. The waste of expenditure in George might have been saved had the powers that be listened to advice.

If the Provincial Auditors had the effrontery to tell Municipal Councils that they are not providing for Reserves and Obsolescence they would probably be told where they got off, and it is highly probable that such advice would be completely ignored and the Municipal funds diverted to other purposes. I am afraid I have been a little outspoken on this subject, regarding which I sometimes feel very heated indeed. (Applause).

REPLY by Mr. MULLER.

I want to say with reference to the remarks of Mr. Sparks, that I had in mind the smaller Schemes. Schemes such as Mr. Sparks is in charge are not exactly small. The time will inevitably come when the Engineer in charge cannot give his attention to such matter as accounts.

I am convinced that many Engineers who act in a dual capacity are doing a great deal of good for their Towns and I have taken particular care in observing their work and have been singularly struck with the improvements some of these Engineers have made. They are the only men in the small Towns who have the necessary Technical knowledge and I consider it their duty to use such knowledge where they can.

With reference to the comments by my namesake, Mr. Muller, who does not see the sin in paying for extensions from Revenue; while this may not be a sin, he is certainly flirting with sin. We do

not object to pay for the benefit of posterity but there is no need to pay for the benefits which our children will reap, therefore such expenditure from Revenue should be tempered with utmost discretion.

CONCLUSION AND THANKS.

The President : It only remains for me to thank you all for your attendance, for the very valuable assistance you have given me as President and the interesting and informative way in which the various papers have been discussed.

I hope that in returning to your normal duties you will carry with you the most pleasant recollections of your stay in Durban. (Applause).

Councillor James (Capetown) : May I, on behalf of the delegates, thank His Worship the Mayor, the members of the City Council and the Committee responsible for carrying out this very successful Convention. We are all going to take with us very happy memories of the enjoyable time we have spent with you and we are going to profit from what we have listened to.

All in Durban have been most kind and we are looking forward to the next Convention when we hope in some small measure to return something of the great kindness you have shown us.

The City of Durban has been fortunate in many ways, and we shall certainly look forward to the occasion of our next visit here. (Applause). For myself, it has been a great pleasure for me to make the acquaintance of so many fine people who have only one idea—service to the community. I formally move this vote of thanks and appreciation. (Applause).

Councillor Leslie Fereday (Salisbury) : I am very glad to have the opportunity of associating myself with the remarks of Councillor James.

You in Durban have given us an extraordinarily good time, and we will take away with us many pleasant recollections of our visit. If I may, I would like to say that I am pleased to associate myself with Councillor James in other matters, notably with his views on the subject of contributions to the relief of rates. I liked his paper for many reasons, but chiefly because of the unmistakable evidence it indicated concerning the spirit of co-operation that exists between himself and his technical advisers. (Hear, hear). When a councillor fully appreciates the fund of information that is available to him from the technical staff there is some possibility of his talking sense, (Hear, hear), at any rate he begins to understand the problems with which he is confronted.

I feel that Durban and Salisbury have something in common; for instance, they both became cities in the same year, although I think Salisbury may have been a little earlier in that year. Then in point of progress and importance we are very similar. However, that may be, we have this in common :— We in Salisbury, like Durban, have been guilty in taking money from the electricity undertaking for the relief of rates (Ltr.) but we have long since reformed, at any rate to some extent, and having the experience gained at this Convention behind us, I think my colleague and myself will go back more determined than ever to effect some reform in regard to this matter. (Hear, hear).

There have been many things to make our attending this Convention worth while. Some of us have come a long way, and we definitely think it worth while. We have been pleased with many things that have happened. I would refer to the fact that you have elected to the Council of your Association Mr. Clinton, electrical engineer of Salisbury. That is not only a compliment to him, but to the City we represent and to Southern Rhodesia. I feel that I must also refer to the very fine gesture made by Mr. Swingler in regard to

the electing of your Vice-President. I think his standing down for a younger man was a very fine gesture (App.) Perhaps a councillor values these things more than the engineer, but I must say that Mr. Swingler's attitude struck me very forcibly. It was typical of the spirit animating electrical engineers.

This Congress enables us councillors more fully to appreciate the engineers' point of view and to be of more use to our communities. I congratulate the Council of the Association upon the conducting of its affairs and the way in which all the arrangements for the Convention have been carried out. I would also like to offer you, Mr. President, my sincere congratulations upon your election to that high and responsible office. I am sure you will forgive my saying that you are not one who talks a great deal; you cut the cackle and do the work. (Hear, hear), and we trust you will continue in the excellent way you have begun. (Applause).

Councillor Gray (Johannesburg) : I have a message to deliver, and that is to convey the greetings and goodwill of our Mayor and our City Council, all of whom recognises the great value and usefulness of the electrical engineer. I have enjoyed this Convention very much indeed, and there can be no denying its tremendius value. (Applause).

Councillor Middlebrook (Durban) : In the absence of the Chairman of the Durban City Council's Electricity Committee, it falls to my lot to acknowledge, on behalf of the City Council, the gracious words of thanks spoken by Councillor James and Councillor Fereday.

We cannot offer you the rugged grandeur and the beautiful surroundings of the city known as the Tavern of the Southern Seas, or the distinctive moisture of Stellenbosch in which to earth your electrodes, the resistivity of which you will have an opportunity of testing next year. I hope that

no fatal or legal results will ensue, and that at some future date you will again enjoy the charms of that coy maiden, Durban. Max O'Rell, after touring South Africa, dubbed this green-dressed city the most coquettish town in Africa. Come and embrace her again with even greater enthusiasm ! Durban bids your Convention boodbye; God bless each one of you and prosper your Association in the years to come. (Applause).

The President : I have to thank you very much indeed for your kind remarks. I can only say I have tried to do my best. It now only remains for me to close the Convention and say "Goodbye !"

Mr. Ritson (Stellenbosch) : I move as an unopposed motion that we wish our President a very successful year of office. (Applause.

The Convention then terminated.

Association of Municipal Electricity Undertakings.

of South Africa and Rhodesia.

LIST OF VARIOUS MEMBERS,

as at December, 1937.

HONORARY MEMBERS.

H. J. van der BIJL, Electricity Supply Commission, Johannesburg.
E. POOLE, Box 147, Durban. (Secretary and Treasurer).

COUNCILLOR MEMBERS.

Adelaide.
Alice.
Beaufort West.
Benoni.
Bloemfontein.
Burgersdorp.
Cape Town.
Cradock.
Durban.
East London.
Ermelo.
Eshowe.
Fort Beaufort.
Fort Victoria.
Gatooma.
George.
Graaff-Reinet.
Grahamstown.
Gwelo.
Johannesburg.
Kimberley.
Klerksdorp.
Kokstad.
Krugersdorp.
Ladybrand.
Ladysmith.
Mafeking.
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