

This electronic version (PDF) was scanned by the International Telecommunication Union (ITU) Library & Archives Service from an original paper document in the ITU Library & Archives collections.

La présente version électronique (PDF) a été numérisée par le Service de la bibliothèque et des archives de l'Union internationale des télécommunications (UIT) à partir d'un document papier original des collections de ce service.

Esta versión electrónica (PDF) ha sido escaneada por el Servicio de Biblioteca y Archivos de la Unión Internacional de Telecomunicaciones (UIT) a partir de un documento impreso original de las colecciones del Servicio de Biblioteca y Archivos de la UIT.

هذه النسخة الإلكترونية (PDF) للاتصالات الدولي الاتحاد في والمحفوظات المكتبة قسم أجراه الضوئي بالمسح تصوير نتاج (ITU) والمحفوظات المكتبة قسم في المتوفرة الوثائق ضمن أصلية ورقية وثيقة من نقلاً.

此电子版（PDF版本）由国际电信联盟（ITU）图书馆和档案室利用存于该处的纸质文件扫描提供。

Настоящий электронный вариант (PDF) был подготовлен в библиотечно-архивной службе Международного союза электросвязи путем сканирования исходного документа в бумажной форме из библиотечно-архивной службы МСЭ.

© International Telecommunication Union

COMITÉ CONSULTATIF INTERNATIONAL TÉLÉPHONIQUE

XIth PLENARY MEETING

Copenhagen, 11th—20th June, 1936

ENGLISH EDITION

COMITE CONSULTATIF INTERNATIONAL TELEPHONIQUE

(C.C.I.F.)

PROCEEDINGS OF THE
XIth PLENARY MEETING
Copenhagen, 11th—20th June, 1936

TRANSLATED INTO ENGLISH
BY
THE TECHNICAL STAFF OF
THE INTERNATIONAL STANDARD ELECTRIC CORPORATION

ENGLISH EDITION
Issued by The International Standard Electric Corporation, 1938

Made and Printed in Great Britain by Hunt, Barnard & Co., Ltd., London & Aylesbury.

PREFACE

THIS volume contains an unofficial translation of the French text of the Proceedings of the Comité Consultatif International Téléphonique (C.C.I.F.) at its Plenary Session in Copenhagen, June 11th–20th, 1936. The form of the present translation differs from that of previous years in that, for the most part, only the changes in and additions to the previous volume (1934), resulting from the Copenhagen decisions, have been given. A large portion of the recommendations and information contained in the 1934 Edition still remains in force. It has been found by past experience that the publication of a complete new set of recommendations, many of which are but modified forms of those previously in force, has at times led to some confusion. Even where confusion does not arise, there is constant need for referring to both the old form and the new form of such recommendations. In an endeavour to facilitate the comparisons between the old and the new texts the present method has been employed for all sections other than those dealing with Protection. In this latter section it has not been possible to follow this procedure because of the complete rearrangement and renumbering of existing recommendations and the very numerous changes which have been made in the 1934 text. Part I of this volume (Protection) will, therefore, be found to be a direct translation of Vol. II-bis of the 1936 French edition of the C.C.I.F. " White Book " containing all recommendations and information concerning Protection as amended and brought up-to-date by the Copenhagen Meeting.

For purposes of reference an Appendix has been added to the present volume summarizing the more important new recommendations made at the Oslo meeting of the Technical Commissions (June–July, 1938). Certain of these recommendations have been submitted to Administrations and Operating Companies adherent to the C.C.I.F. for a postal vote, and, if passed, will be considered as being provisionally in force as at January 1st, 1939. The remainder will be submitted in the usual manner to the next Plenary Meeting.

SPECIAL NOTE

In order to co-ordinate this present volume with the 1934 English edition and the corresponding 1934 and 1936 French texts, a complete index has been prepared which not only indicates where recommendations and information relating to a given subject may be found in both the English and the French volumes, but also indicates whether the corresponding recommendations or information are new, are a modification of the previous text, or are maintained as in the 1934 text without change.

Reference should always be made to the Index which appears at the end of the present Volume. An explanation as to the method of using this Index will be found on page 349.

INTERNATIONAL STANDARD ELECTRIC CORPORATION.

CONTENTS

GENERAL PAGE

List of Delegates to the XIth Plenary Meeting of the C.C.I.F 7
Minutes of the Opening Session 14
Minutes of the Meeting of the Chief Delegates 17
Minutes of the Closing Session 21

PART I. Protection

Protection of telephone lines against the interfering effect of heavy current or high tension power systems 28
Protection of telephone cables against corrosion due to electrolysis 53
Protection of telephone cables against chemical corrosion 77
Constitution of telephone cable sheath 79

PART II. Transmission and Maintenance

Changes and additions to the section of the English Edition 1934, entitled "QUESTIONS OF TRANSMISSION AND MAINTENANCE" 80

PART III. Operating and Tariffs

Changes and additions to the section of the English Edition 1934, entitled "RECOMMENDATIONS CONCERNING QUESTIONS OF OPERATING AND TARIFFS" 225

PART IV. List of questions set for study by the XIth Plenary Meeting:

List of questions concerning protection against interference 239
List of questions concerning protection against corrosion 243
List of transmission questions 252
List of questions on operating and tariffs 309

PART V. Composition of the Commissions of Rapporteurs of the C.C.I.F. in 1937 and 1938 313

PART VI. List of C.C.I.F. Recommendations in force on January 1st, 1937.. .. 317

APPENDIX. Summary of Principal Recommendations made by the 3rd, 4th and 5th C.R.'s at their meeting in Oslo, June 20th to July 2nd, 1938 ... 333

INDEX 349

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

INTERNATIONAL TELEPHONE CONSULTATIVE COMMITTEE

(C.C.I.F.)

XIth Plenary Meeting, Copenhagen, 11th—20th June, 1936.

LIST OF DELEGATES.

Former delegate (guest): Mr. Anders Lignell, late Director of Telephones, Stockholm, Sweden)

A.—DELEGATES FROM TELEPHONE ADMINISTRATIONS AND OPERATING COMPANIES.

1. Administrations or Operating Companies belonging to the C.C.I.F.

SOUTH AFRICA	Not represented.
GERMANY	Mr. K. Höpfner, Ministerial Director (*Chief Delegate*). Dr. P. Jäger, Ministerial Councillor. Mr. K. Ehlers, Ministerial Councillor. Mr. F. Gladenbeck, Chief Councillor of Posts. Mr. K. Braun, Councillor of Posts. Dr. H. Klewe, Councillor of Posts. Mr. P. Oehlen, Engineer.
ARGENTINE ... ... (*Republic*)	Mr. F. Gill (*Chief Delegate*). Mr. Hallgren. Mr. E. Swensen, representing the Compañia Telefónica del Rio de la Plata and the Compañia Telefónica Argentina. Dr. F. Lüschen. Dr. H. F. Mayer. Dr. C. A. Hartmann, representing la Compañia Telegrafico Telefónica del Plata. Mr. Max Langer. Mr. W. Rabanus, representing la Compañia Internacional de Telefónos.
La Compania Transradio Internacional.	Not represented.
AUSTRIA	Mr. Rudolf Heider, Ministerial Councillor (*Chief Delegate*). Mr. Rudolf Oestreicher, Ministerial Councillor.
BELGIUM	Mr. J. Van Ubbel, Engineer-in-Chief, Director of Telephones (*Chief Delegate*). Mr. Parfondry, Engineer-in-Chief, Assistant Director of Telephones. M. Henri Fossion, Assistant Director of Telephones. Mr. Haemers, Engineer-in-Chief, Assistant Director of Studies and Material.

CHILE

Compania de Telefonos de Chili

Mr. E. Deloraine (*Chief Delegate*).
Mr. W. Hatton.

CHINA ... ... Mr. Kee Tsing Li.

CUBA

Cuban Telephone Company ... Mr. P. E. Erikson, Assistant Vice-President (*Chief Delegate*).
Mr. Van Hasselt, Engineer.
Mr. L. C. Pocock, Engineer.

DENMARK

Direction General of Posts and Telegraphs

Mr. C. Mondrup, Director General (*Chief Delegate*).
Mr. M. Gredsted, Chief of the International Operating Service.
Mr. O. I. Ellekilde, Chief Telegraph Engineer, Chief of the Cable Services.
Mr. N. E. Holmblad, Engineer, Technical Section of Telegraphs and Telephones.
Mr. A. Krog, First Secretary, International Operating Service.
Mr. J. Jansen, Assistant Department Chief, International Operating Service.

Supervision of the Concessionaire Telephone Companies

Mr. Axel Petersen, Engineer.
Mr. O. C. Thomsen, Lt. Col., Engineers.

Copenhagen Telephone Company

Mr. C. R. Michelsen, Director-Administrator.
Mr. P. V. Christensen, Engineer-in-Chief.
Mr. G. Irming, Engineer-in-Chief.
Mr. V. Clausen, Engineer-in-Chief.
Mr. L. Saltoft, Chief Engineer.

Fyn Telephone Company ... Mr. J. v. Linstow, Director-Administrator.
Mr. E. Koch, Engineer-in-Chief.
Mr. M. Teglbjerg, Engineer.

Jutland Telephone Company ... Mr. J. Wallmann, Director, Administrator.
Mr. H. Plessing, Engineer-in-Chief.
Mr. J. Wibrand, Engineer-in-Chief.

Lolland-Falster Telephone Company

Mr. H. A. Klausen, Telephone Engineer.

DANZIG (*Free City of*) ... ... Not represented.

SPAIN

Direction General of Telecommunications

Mr. Cesar M. Nieves Guardiola, Chief of International Traffic (*Chief Delegate*).
Mr. Buenaventura de las Penas y Gismero, Engineer.

Compañia Telefonica Nacional de España

Mr. E. del Riego Salazar, Section Chief.

ESTONIA ... ... Not represented.

UNITED STATES OF AMERICA *American Telephone and Telegraph Company.*	Mr. H. P. Charlesworth, Assistant Chief Engineer (*Chief Delegate*). Dr. L. F. Morehouse, Technical Representative in Europe of the A. T. & T. Company. Mr. G. C. Barney, Assistant Technical Representative in Europe of the A. T. & T. Company.
FINLAND	Mr. P. O. Suramo, Cable Engineer to the Direction General of Posts and Telegraphs (*Chief Delegate*). Mr. E. von Schantz, Managing Engineer of the Helsinki Telephony Company. Mr. J. Rosberg, Engineer, Chief of Department, Section of the Helsinki Telephone Company.
FRANCE	Mr. Drouët, Inspector General (*Chief Delegate*). Mr. Aguillon, Engineer-in-Chief. Mr. Le Corbeiller, Engineer-in-Chief. Mr. Collet, Engineer-in-Chief. Mr. Malézieux, Engineer-in-Chief. Mr. Debry, Exchange Chief. Mr. Bélus, Engineer. Mr. Chavasse, Engineer. Mr. Bigorgne, Engineer. Mr. Simon, Engineer. Mr. Rigollet, Assistant Department Chief.
GREAT BRITAIN	Col. A. G. Lee, Engineer-in-Chief of the British Post Office (*Chief Delegate*). Mr. W. H. Weightman, Divisional Chief, Direction of Telecommunications. Mr. B. S. Cohen, Engineer, Director of Research. Mr. J. G. Hines, Engineer, Divisional Chief. Mr. A. C. Timmis, Engineer. Mr. P. B. Frost, Engineer. Mr. G. W. Gomm, Traffic Inspector, Direction of Telecommunications. Mr. R. M. Chamney, Engineer. Dr. W. G. Radley, Engineer. Mr. S. T. Keyte, Divisional Chief, Financial Department. Mr. F. E. A. Manning, Engineer. Mr. M. W. West, Engineer, Research Section.
HUNGARY	Mr. Désiré de Véghely, Chief Technical Director of Posts, Chief of the Telephone Technical Section (*Chief Delegate*). Dr. François Havas, Director of Posts, Chief of the International Telecommunication Group of the Telegraph and Telephone Operating Division. Dr. Ivan Tomits, Technical Councillor of Posts, Assistant Chief of the Research Institute of Posts. Mr. Géza Bernauer, Director of the Hungarian "Ericsson" Company (as an observer).

DUTCH INDIES	Not represented.
ICELAND	Not represented.
ITALY	Mr. Aldo Baldini, Engineer, Chief Technical Inspector of the Royal Experimental Institute of Communications, P.T.T. Section (*Chief Delegate*). Prof. Elvio Soleri, Societa Torinese Esercizi Telefonici (S.T.E.T.). Mr. Giovanni Silva, Engineer, Societa Torinese Esercizi Telefonici (S.T.E.T.).
JAPAN	Mr. Kanichi Ohashi, Engineer to the Ministry of Communications (*Chief Delegate*). Mr. Shizuo Honda, Engineer to the Ministry of Communications. Mr. Atsushi Kimpara, Engineer to the Ministry of Communicacations. Mr. Dan, Secretary-Interpreter.
LETTONIA	Not represented.
LITHUANIA	Not represented.
LUXEMBOURG (*Grand Duchy of*) ...	Not represented.
MEXICO	Mr. M. Vos, D.Sc. (*Chief Delegate*) Mr. H. Blomberg, Engineer. Mr. F. Markman, Engineer. Mr. G. Segerström, Engineer, representing l'Empresa de Teléfonos Ericsson. Mr. E. A. Brofos, representing the Mexican Telephone and Telegraph Company.
MOZAMBIQUE	Not represented.
NORWAY	Mr. M. Storström, Engineer-in-Chief of the Direction General of Telegraphs (*Chief Delegate*). Mr. Martin Wahl, Department Chief. Mr. S. Rynning-Tönnessen, Chief Engineer. Mr. H. Eire, Director of the Bergen Telephone Company.
HOLLAND *Direction-General of Telephones.*	Mr. H. J. Boetje, Engineer-in-Chief, Director of the Technical Service of Telegraphs and Telephones (*Chief Delegate*). Mr. Th. W. L. M. de Winter, Inspector of Posts, Telegraphs and Telephones, Chief of the Telephone Division. Mr. J. Winkel, Engineer-in-Chief of Telegraphs and Telephones. Mr. J. Tj. Visser, Engineer of Telegraphs and Telephones, Concessionaire Municipal Telephone Networks. Mr. G. C. Snijders, Engineer, Director of the Municipal Telephone Service of Amsterdam.

POLAND	Mr. Stanislas Debicki, Chief of the Operating Department of Telegraphs and Telephones, of the Ministry of Posts, Telegraphs and Telephones (*Chief Delegate*). Mr. Henri Pomirski, Chief of the Cable Department of the Ministry of P.T.T. Mr. Constant Dobrski, Section Chief of the National Institute of Telecommunications. Mr. Czeslaw Rajski, Laboratory Chief of the State Tele- and Radio-communications. Mr. Witold Novicki, Engineer of the National Institute of Telecommunications.
PORTUGAL	Mr. A. de Q. R. Vaz Pinto, Engineer, Assistant Administrator of Posts and Telegraphs (*Chief Delegate*). Mr. C. G. S. Ribeiro, Engineer, Divisional Chief of Research, Construction and Maintenance of the Administration of Posts and Telegraphs.
RUMANIA *Societatea Anonima Romana de Telefoane.*	Mr. J. J. Parsons, Assistant Director-General (*Chief Delegate*). Mr. B. H. McCurdy, Assistant Chief Engineer. Mr. N. N. Racotta, Traffic Director.
SWEDEN	Mr. A. Holmgren, Department Chief of the Telegraph Administration (*Chief Delegate*). Mr. E. Halling, Director of Telephones, Stockholm. Mr. S. Nordström, Chief Engineer, Telegraph Administration. Mr. G. Swedenborg, Section Engineer.
SWITZERLAND	Mr. A. Muri, Head of Technical Division (*Chief Delegate*). Mr. A. Möckli, Chief of Telephone Section. Dr. H. Keller, Chief of Test Section.
CZECHO-SLOVAKIA	Mr. J. Stowasser, Engineer, Ministerial Councillor (*Chief Delegate*). Mr. Fr. Matous, Ministerial Councillor. Mr. J. Michalek, Engineer, Councillor.
UNION OF SOVIET SOCIALIST REPUBLICS	Prof. Mikhail Lapirov-Skoblo, Director of the Institute of Telecommunications, Scientific Research (*Chief Delegate*). Madame Olga Babourina, Director of the Moscow Long Lines Station. Prof. Pavel Azboukin, Chief of the Laboratory for the Protection Lines, of the Telecommunication Scientific Research Institute.
URUGUAY	Dr. F. Lüschen. Representative of the State Administration General and of the Compañia Telefónica de Montevideo.
YUGOSLAVIA	Mr. Lyoubomir Terzitch, Chief of the Technical Services, Ministry of P.T.T.

EXPERTS (*For the C.R. Meetings*)... Dr. Arendt, A.E.G., Berlin.
Dr. Jordan, A.E.G., Berlin.
Dr. U. Meyer, Felten & Guilleaume Carlswerk A.G., Köln-Mülheim.
Dr. Grützmacher, Government Councillor, Physikalisch-Technische Reichsanstalt, Berlin.

2. Representatives of International Organisations collaborating with the C.C.I.F.

(1) *International Telegraph Consultative Committee* (*C.C.I.T.*).

Mr. Hillekilde, of the Danish Telegraph Administration, at the request of the Polish Telegraph administration, Manager of the C.C.I.T.

(2) *Bureau of the International Union of Telecommunications.*

Mr. Boulanger, Vice-Director.

B.—DELEGATES FROM ELECTRO-TECHNICAL ASSOCIATIONS.

1. International Electro-Technical Committee.

Dr. Whitehead.

2. International Railway Union.

Mr. Müller.
Mr. Bachellery.
Mr. Leboulleux.
Mr. Micarelli.
Prof. Hellenthal.
Mr. Ofverholm.

3. International Conference of Large High Tension Electric Networks.

Mr. Soleri.
Dr. Dahl.

4. International Union of Producers and Distributors of Electric Power.

Mr. Hartmann.
Mr. Mungioli.

5. International Broadcasting Union.

Mr. Braillard, President of the Technical Committee and Director of the Control Centre of the Union.
Mr. E. L. E. Pawley, Engineer, British Broadcasting Corporation, London.

Secretariat General of the C.C.I.F.

Mr. Georges Valensi, Secretary-General.

Mr. Mahé
Mr. Ollier
Mr. Parmentier
Mr. Labrousse
Mr. Marzin
} Secretaries.

Mr Lavoignat, Department Chief.
Mlle. Félix.
Mme. Brunet.

Administration of the Plenary Meeting.

Reception Committee.

(Administration and Reception.)

Mr. M. Gredsted, Chief of the International Operating Section, President.
Mr. E. A. Hansen, Telegraph Engineer.
Mr. A Krog. First Secretary to the International Operating Section.
Mr. A. B. Ilslev, Assistant Department Chief of the Technical Section.
Mr. J. Jansen, Assistant Department Chief of the International Operating Section.

Ladies' Committee.

Mmes. Sara Gredsted, Minna Bjerg, Grete Holmblad, Rigmor Krog, Yvonne Saltoft.

Reception Department.

Mr. J. M. S. Andersen, Assistant Department Chief.
Mme. K. Jerntved.
Mme. A. Jessen.
Mlle. H. Andersson.
Mlle. Lull Sletting.

Information.

(Documents, Messengers).
Mr. C. Pellesson.
Mr. K. Skibbyholm.

Post, Telegraph, Telephone.

Mr. K. Sörensen, Controller.
Mme. I. M. Pedersen.
Mlle. I. S. Hansen.

Stenographic Service.

Mr. K. E. Enochsen.

MINUTES OF THE OPENING SESSION

(11th June, 1936).

The meeting opened at 10.0 a.m.

Mr. Mondrup, Director-General of Posts and Telegraphs of the Kingdom of Denmark: Gentlemen, on behalf of the Royal Government of Denmark, and as a representative of the Minister of Public Works detained by his manifold duties, I have the honour to bid you the most cordial welcome to Denmark and to its capital, Copenhagen.

It is with pleasure that the Danish Government has invited you to hold the XIth Plenary Meeting of the International Telephone Consultative Committee at Copenhagen. We thank you for having accepted this invitation, and we ask you to believe that we will do our best to render your stay in our country as pleasant as possible.

My country, which has followed with the greatest interest the developments in the telephone art during the last ten years, is especially interested in the technical progress leading to the assurance of the perfect operation and good organization of international telephony with a view to offering to the public, that is to users of the international telephone, a service both rapid and economical.

Here in Denmark we are happily situated because, thanks to our brilliant engineers, our internal telephone service has undergone a remarkable development which has allowed of our assuring to international telephony the requisite conditions for satisfying the needs of subscribers.

Here, you are in the natal country of Hans Christian Œrsted, discoverer of electro-magnetism, of which telephony is one application. I am confident that, as usual, a spirit of collaboration, of cordiality and of friendliness will reign among the delegates of Telephone Administrations and Operating Companies here gathered together.

It is an agreeable duty for me to salute first of all the late Director of Telephones for Stockholm, Mr. A. Lignell, founder-member of the C.C.I.F., who has shown the interest he still has in the progress and work of the C.C.I.F. by accepting the invitation to take part in this Plenary Meeting as an honorary delegate. Unfortunately, a slight indisposition has confined Mr. Lignell to his room to-day, but we shall soon have the pleasure of seeing him among us. You will remember the excellent contributions he has made to the work of the C.C.I.F. during many years and his amiable personality is so well known to you that I feel sure that in extending a special welcome to Mr. Lignell I am carrying out your wishes. (Loud applause.)

I should have liked to welcome in a similar manner as honorary delegate Mr. T. Engset, late Director-General of Norwegian Telegraphs. Unfortunately Mr. Engset has been prevented from accepting the invitation sent to him as he advises me by a letter dated May 25th which reads as follows :—

> To the Direction General of Posts, Copenhagen,
>
> " I beg the Direction General to accept my most sincere thanks for the great honour it has done me and the good will it has shown towards me in inviting me on May 20th last to participate as a guest in the XIth Plenary Meeting of the C.C.I.F. at Copenhagen from 11th to 20th June.
>
> " On account of the interest I take in the discussions about to be opened and the great importance also which these have for my country, I should have been glad to have been present to meet my collaborators and friends, but I regret to inform you that for private reasons I cannot come to Copenhagen at this time.

" The C.C.I.F. has carried on its work under happy auspices. The result of the activities of this institution set a good example of international negotiation, and it is impossible to value too highly its importance for civilisation and humanity, for material and intellectual progress, and its field of activity is still a vast one.

" My most sincere wishes for the work of the C.C.I.F. and I beg that the President and Members of the Conference will receive my homage and my respectful and cordial greetings.

" Thanking especially the Director General, Mr. Mondrup, I present to you, Gentlemen, my best compliments.

Yours devotedly,

T. E. Engset."

We very much regret the absence of Mr. Engset, our old and highly qualified collaborator ; we thank him for his kind words and send him our best wishes for happiness and prosperity in his retirement.

I also wish to express our regards and to send a kind greeting to others of our late collaborators who have retired, Mr. Chocholin of the Czechoslovakian Administration, Colonel Shreeve of the A. T. & T. Company and Mr. Hart of the British Post Office. I also wish to salute Mr. Hombrey Chalbaud of the Spanish Administration and Mr. Serrao of the Portuguese Administration, who, by reason of a change in their functions, no longer collaborate in the work of the C.C.I.F. ; I request the Chief Delegates of Spain and Portugal to remit to them our thanks for their long and efficient collaboration.

Finally, I salute very cordially on behalf of us all Mr. Boulanger who represents the International Telecommunications Union, and the Secretary-General of our Committee, Mr. Georges Valensi.

I have pleasure in informing you, gentlemen, that the Greek Telephone Administration has joined the C.C.I.F. as from 1st January, 1937. On the other hand, I regret to announce that the Albanian Telephone Administration has withdrawn from our association.

As a distraction from the important labours which you have to perform, we intend to show you a few of the beauties of our country so that you may have a correct impression of the Danish countryside and people.

Gentlemen, I now have to request you to appoint the President of the XIth Plenary Meeting of the C.C.I.F.

Mr. Höpfner, Ministerial Director : I think I am expressing the wish of all the delegates in proposing that the Director-General of Posts and Telegraphs of Denmark should be President of the XIth Plenary Meeting of the C.C.I.F., 1936. (Loud applause.)

Mr. Mondrup : I heartily thank the Plenary Meeting for the great honour they have done me in nominating me as President. I accept this office, and I am deeply touched by this mark of confidence on the part of my esteemed foreign colleagues. I shall do my best to direct your labours, and I promise you the heartiest co-operation on the part of my Administration.

I should like, however, to have the assistance of three Vice-Presidents in charge respectively of the meetings of Transmission, Protection and Operating. I propose Mr. Höpfner for Transmission, Col. Lee for Protection and Mr. Muri for Operating. Does the Meeting approve these proposals, and are Messrs. Höpfner, Col. Lee, and Muri willing to act ? (Loud applause.)

Mr. Höpfner : I thank you for the honour you have done me in nominating me Vice-Presiden tin charge of the Transmission Meetings. I will do my best to carry out this task. (Applause.)

Col. Lee : Mr. President, I thank you for the honour you have done me in nominating me Vice-President in charge of Meetings on Protection.

Mr. Muri : I thank you for the honour you have done me in entrusting me with the Vice-Presidency of the Meetings on Operating and Traffic.

Mr. Mondrup : I propose appointing as Assistant-Secretaries to Mr. Valensi, our Secretary-General : Mr. Mahé, for Operating, Mr. Ollier for Protection, and Messrs. Parmentier, Labrousse and Marzin for Transmission. (Applause.)

I further wish to request the Delegates to agree that all communications to be made through the Press should be centralised in the President of the Meeting, who will undertake to edit all communications to the Press. In consequence, the Delegates will not have to get into direct touch with the Press as far as concerns the discussions of the XIth Plenary Meeting of the C.C.I.F.

As the weather is fine, we are going in a few moments to take a photograph of the Delegates and their ladies, outside, at the foot of the grand staircase.

Following that, in conformity with the programme, the first Transmission Meeting will be held in another room, at the far end of the hall.

Does anyone wish to speak ?

Gentlemen, the meeting is closed. (Loud applause.)

MINUTES OF THE CHIEF DELEGATES' MEETING

(19th June, 1936).

The meeting opened at 2 p.m. under the presidency of Mr. Mondrup.

(1) The Chief Delegates first examined the question, raised by the Administration of the Dutch Indies, of the classification in the table relative to the contribution towards the expenses of the C.C.I.F. of countries having very little telephonic relationship with the majority of other countries which are members of the C.C.I.F.

The text of this question was as follows :—

" Should the rules of the C.C.I.F. be modified to allow countries which of necessity have very little telephonic relation with other countries to be classified from the point of view of their subscriptions to the expenses of the Committee, into a classification lower than that laid down by the rule as at present constituted (this rule lays down that Administrations and Operating Companies have a choice between the division table of the expenses of the International Telecommunications Union and a table based on population—see page 133 of the Index and Errata of the White Book [Budapest, 1934]) ? "

After an exchange of views, it was decided to add the following text after the 18th line of page 133 of the Index and Errata volume of the White Book of the C.C.I.F. (Budapest 1934) :—

" If a non-European country having : (1) very little telephonic relation with other countries who are members of the C.C.I.F. and (2) a small internal telephone development, considers it is justified in asking to be placed in a class below that which would result from the application of the above (rule), it should address such request to the Secretariat of the C.C.I.F. explaining the reasons for such re-grading claim, and proposing the new class in which it desired to be classified from the point of view of contribution to the expenses of the C.C.I.F. The Auditors would in such a case come to a provisional decision, pending ratification by the next Plenary Meeting."

Following this decision, Mr. Boetje expressed to the Chief Delegates his very sincere thanks for the reception they had given to the request put forward by the Dutch Indies Administration.

(2) The Chief Delegates then examined the Management Report for 1936.

In accordance with the suggestions made by the 4th C.R., the number of operators of the SFERT Laboratory must be increased by one unit. On this subject, Mr. Holmgren stated that the question of attaching a member of the Swedish Administration Staff to the SFERT Laboratory would shortly be decided.

With reference to the general information collected by the Secretariat General (translations of technical articles not being C.R. documents), it was decided that the Secretary General would send to Administrations and Operating Companies two circulars—the first would indicate the technical publications which are at present sent to the Secretariat of the C.C.I.F., and will ask for technical publications which do not figure in this list, but which are of interest on the subject of long distance telephony, to be sent to the Secretariat, and in this connection it would be an advantage to ask the telephone engineers of the various countries to send to the Secretariat of the C.C.I.F. copies of such of their articles or memoirs as directly concern questions studied by the C.C.I.F.; the second circular would ask the Administrations and Operating Companies if they wished to receive the whole of the general information, or if not, which particular subjects are of interest to them.

Mr. Boulanger then stated that the Secretariat General, after consultation with the library of the Journal des Télécommunications at Berne, could obtain from the Bureau de l'Union Internationale des Télécommunications a copy of the technical review which contains an article directly concerning the work of the C.C.I.F. which had not been received by the Secretariat.

The Management Report for 1936 was then approved.

(3) The chief delegates then examined the proposals to be made during the closing session of the Plenary Assembly on the subject of approximate dates and places of forthcoming meetings of the C.R. and of the Plenary Assembly of the C.C.I.F.

The date proposed for the 6th and 7th C.R.'s dealing with new questions of Operating and Traffic and for the mixed commission for the General European Toll Plan is September 1937. Mr. Drouët stated that the French Telephone Administration would be glad for this meeting to be held in Paris. This proposal was accepted. (Applause.)

The date proposed for the meeting of the technical C.R.'s (1st, 2nd, 3rd, 4th and 5th) is June 1938. Mr. Rynning-Tönnessen, on behalf of the Norwegian Delegation, stated that he was authorised to propose that this meeting should be held at Oslo. This proposal was accepted. (Applause.)

Seeing that the International Telegraph Conference would be held at Cairo in 1938, the chief delegates decided to ask Mr. Boulanger to be good enough to request the Director of the Bureau de l'Union Internationale des Télécommunications to ask the Director General of Posts, Telegraphs and Telephones of Egypt, if it would be possible, in a similar way to the procedure adopted at Madrid 1932, to hold at Cairo early in February 1938 the XIIth Plenary Assembly of the C.C.I.F. which would be of very short duration and devoted solely to questions of Operating and Traffic.

The XIIIth Assembly of the C.C.I.F. due in 1940, would deal, on the other hand, with all questions (technical or operating). Concerning this, Mr. de Q.-R. Vaz Pinto made the following statement :

" Mr. President, Gentlemen,

" I have the pleasure in suggesting Lisbon as the site of the Plenary Assembly in 1940.

" The Portuguese Administration, which is now undertaking the complete reorganisation of all its services, is planning to carry out important constructional work, either a rearrangement of its present installations, or construction of new installations, in accordance with a plan which is already almost decided upon.

To emphasize not only its appreciation of the remarkable results of the work of the C.C.I.F., but also to express its firm desire for effective collaboration, the Portuguese Administration would be glad to have the honour of seeing a Plenary Meeting held in its territory. For that reason I have been appointed on behalf of my Government to inform you that it would be extremely happy to receive you in Portugal.

This proposal was accepted. (Applause).

The President thanked Messrs. Drouët, Rynning-Tönnessen and de Vaz Pinto for their kind invitations and asked them to convey to the French, Norwegian and Portuguese Administrations the assurance that the members of the C.C.I.F. would be extremely happy to visit Paris, Oslo and Lisbon for the meetings of the C.C.I.F.

It was understood that the " Committee for revision of the Directives " (for the protection of telephone lines against harmful influences from industrial lines) and the " Committee for the revision of Recommendations " (for the protection of telephone cables against electrolytic corrosion) would meet in the Spring of 1937 in the offices of the C.C.I.F. at Paris, this meeting being followed by demonstrations or experimental proof by the C.M.I.

The chief delegates then proceeded to discuss the best organisation to be adopted for future Plenary Meetings.

Col. Lee stating that generally, in the course of Plenary Meetings, proceedings were confined to reading and adopting without any modification the proposed recommendations drawn up by the C.R.'s —who, in actual fact, did all the work—asked if it would not be possible for the C.R. meetings to be followed by meetings for the reading and approval of the proposed recommendations which these C.R.'s

had drawn up. These meetings for reading and approval of the final text at which delegates of countries not taking part in the C.R.'s could assist, would replace the Plenary Meeting, which would in future be abandoned.

Mr. Gill declared that after collaborating for many years in the work of the C.C.I.F., he had come to the conviction that Plenary Meetings were extremely useful ; without doubt, the C.R.'s carried out a large part of the work, but it was during the Plenary Assembly that delegations from all countries belonging to the C.C.I.F. supplied fuel for the machine ; if the Plenary Assembly was suppressed, the life of the C.C.I.F. would risk being slowed up ; also, the personal contacts which were made between the telephone engineers of the various countries greatly facilitated the working of the international telephone service.

Mr. Charlesworth remarked that during the C.R. meetings (especially those of the Technical Committees which had a great many questions to study), the work was necessarily confined to drawing up provisional replies summarising the essential points in the solution to be given to each question. There followed the necessary work of editing the text of the proposed modifications or additions to previous recommendations of the C.C.I.F. ; this work, carried out by the Secretariat, required a certain time. Following that, it was usual to transmit these proposals to the Administrations and Operating Companies belonging to the C.C.I.F. some two months before the Plenary Meeting. This two months' delay, especially for the overseas countries, was very short ; also, very often, certain points were left open and had to be studied again, on the basis of tests to be made between the C.R. Meetings and the Plenary Assembly, in order to permit of a satisfactory final text being established. For these reasons, Mr. Charlesworth thought that not only was it necessary to maintain the Plenary Assembly, but also that the interval between the C.R. meetings and the Plenary Meeting should be lengthened. However, instead of combining as had been done at Copenhagen, the C.R. Meeting and the Plenary Assembly, it would be better, suggested Mr. Charlesworth, during the first week to hold meetings of the Committees deputed to edit the text of the modifications and additions to the recommendations of the C.C.I.F. During two or three days of the following week would then be held all the Meetings of the Plenary Assembly necessary to ratify these proposals. The members of the C.R.'s would thus only be occupied for 1½ weeks with the work of the C.C.I.F., and for the majority of the delegates, and particularly for the chief delegates, the Plenary Assembly would only occupy a very few days.

After discussion, Mr. Charlesworth's proposal was adopted, and it was decided to proceed in that manner for the XIIIth Plenary Assembly at Lisbon in 1940.

(4) The chief delegates then approved the accounts for 1934 and 1935 and the budget for 1937 and 1938 without any modifications (report on the budget 1936).

The appointment of the Auditors, Colonel Lee, and Messrs. Höpfner and Bleiner was continued until the next Plenary Meeting. The chief delegates also confirmed the appointment of Mr. Boetje (Holland), Mr. Gredsted (Denmark) and Mr. Heider (Austria) as supplementary Auditors.

Mr. Van Ubbel remarked that the contingency of a general alteration in the salary list might arise, and asked how the necessary readjustment of salaries for the personnel of the Secretariat and of the SFERT Laboratory would be proceeded with. Messrs. Drouët and Muri also observed that it would no doubt be desirable to plan in some fixed manner scales of salaries for the various categories of personnel in the C.C.I.F.

Following a discussion of this question it was decided that the Secretary-General should send to the Auditors a report in which details would be given as to each employee of the Secretariat and of the SFERT Laboratory individually, showing the date of entry into the service of the C.C.I.F., and the payments successively made. The Secretary-General would send with this information his reports on the services rendered, and finally his suggestions for readjustment of salary. These proposals would

have the object, that even in the event of important changes of salary conditions in general in France, the personnel of the Secretariat and of the SFERT Laboratory, would be inclined to remain in the service of the C.C.I.F. rather than to rejoin their original Administration or seek other employment in private service. This information would be examined by the Auditors who in each case would take, if necessary, a provisional decision as to increase of salary, subject to ratification by the next Plenary Assembly. The Auditors would then examine if the next Plenary Assembly should not bring into force for the personnel, both of the Secretariat and of the SFERT Laboratory, a salary increase scale having more or less regular steps similar to that which existed in the international bureaux at Berne.

The supplementary auditors would be kept in touch with the decisions taken in this respect by the auditors in the interval between two Plenary Assemblies.

The session was closed at 4 p.m.

MINUTES OF THE CLOSING MEETING

(20th June, 1936.)

The meeting opened at 2.15 p.m. under the presidency of Mr. Gredsted.

Mr. Gredsted : Ladies and Gentlemen.—Mr. Mondrup, President of the XIth Plenary Meeting of the C.C.I.F., being engaged at the moment in his office, has asked me to replace him temporarily ; later he will occupy the Chair himself.

I call upon the Secretary-General.

Mr. Valensi : Ladies and Gentlemen.—A folder has been issued to you containing the compte rendu of the Plenary Meeting. From this folder I would ask you to be good enough to extract the Minutes of the Chief Delegates' Meeting.

Various Minutes of the last Meeting have also just been handed to you, and these will now be read.

The following Minutes were then read and approved without modification:

Minutes of the Meeting of the Committee for the revision of the " Liste de voies de secours dans le service téléphonique international européen.

Minutes of the Meeting of the 6th and 7th C.R.'s during which revision was made of " l'Instruction pour les opératrices du service téléphonique international européen " and the " Liste des phrases le plus fréquemment échangées dans le service téléphonique international."

Minutes of the third and last meeting of the XIth Plenary Assembly on Operating and Traffic.

Minutes of the Meeting of the Sub-Committee formed by the 4th C.R. to decide upon the filters to be used in obtaining fundamental data for calibrating articulation test crews.

Minutes of the Meeting of the " Commission pour les Programmes de maintenance des circuits européens " and the Minutes of the permanent Sub-committee on maintenance.

Minutes of the fifth and last Transmission Meeting of the XIth Plenary Assembly.

Minutes of the third and last Meeting on Protection against Corrosion, of the XIth Plenary Meeting.

Minutes of the third and last Meeting on Protection against Interference, of the XIth Plenary Meeting.

It was decided that the new recommendations or the modifications to former recommendations of the C.C.I.F. in connection with Operating and Traffic would be applicable as from 1st January, 1937.

The suggestions made in the Minutes of the third and last meeting on protection from interference of the XIth Plenary Assembly, as to the form in which the " compte rendu " of the XIth Plenary Assembly of the C.C.I.F. would be printed (that is two volumes (I bis and II bis) added to the five existing volumes of the " Livre Blanc, 1934 ") were approved, and it was decided that the index in English, German and French should be incorporated in Volume I bis and would clearly indicate where the final text of each recommendation of the C.C.I.F. could be found.

The Minutes of the Chief Delegates' Meeting of the XIth Plenary Meeting were read and the various invitations were applauded : these were by the French Telephone Administration for the Meeting at Paris in September 1937, of the 6th and 7th C.R.'s and of the Mixed Committee for the general European toll plan—by the Norwegian Administration for the Meeting, at Oslo in June 1938, of the 1st, 2nd, 3rd 4th and 5th C.R.'s ; by the Portuguese Telephone Administration for the holding at Lisbon in 1940, of the XIIIth Plenary Meeting of the C.C.I.F. The Meeting also decided to ask the Director of the Bureau de l'Union Internationale des Télécommunications to request the Director-General of Posts, Telegraphs and Telephones for Egypt if it would be possible, in a similar manner to that arranged at Madrid in 1932, to hold at Cairo at the beginning of February 1938, the XIIth Plenary Meeting of the

C.C.I.F., which would be of very short duration and devoted solely to questions of Operating and Traffic.

Mr. Gredsted : Ladies and Gentlemen.—From your applause I gather that the Plenary Assembly has unanimously accepted the invitations of the French, Norwegian and Portuguese Administrations to hold the C.R. Meetings in 1937 at Paris and in 1938 at Oslo, and the Plenary Meeting of 1940 at Lisbon.

I am speaking on behalf of the Plenary Meeting in requesting the Chief Delegates of France, Norway and Portugal to convey to their Administrations our best thanks for these invitations. (Applause.)

Mr. Drouët : Mr. President, Ladies and Gentlemen.—On behalf of the French Telephone Administration I thank you for having arranged for the Meeting at Paris in September 1937 of the 6th and 7th C.R.'s in addition to the Mixed Committee for the general European toll plan. We shall have pleasure in welcoming you once more to Paris, and shall be happy to show you the Exhibition " Arts et technique dans la vie moderne " which is to be held there in 1937.

The French Administration hopes that numerous ladies will accompany those of our colleagues of the C.C.I.F. from various countries who will visit Paris. (Applause.)

Mr. Rynning-Tönnessen : Mr. President, Ladies and Gentlemen.—On behalf of the Norwegian Telephone Administration I have to thank you for having accepted our invitation for the Meeting of the Technical C.R.'s to be held at Oslo in 1938. I welcome you to Norway. (Applause.)

Mr. Vaz Pinto : Mr. President and Gentlemen.—You have just ratified the decision taken at the Chief Delegates' Meeting to select Lisbon as the site of the XIIIth, Plenary Meeting of the C.C.I.F. in 1940. Permit me then to say a few words on the subject of this decision which directly affects my Administration, which attaches to it a very great importance.

You should be proud, Gentlemen, of the work which you have hitherto accomplished. Thanks to you, there is to-day international telephone technique well defined, clear and far-seeing.

You have undertaken courageously the determination of numerous problems both technical and in connection with operating, which the feverish activity of the telephone services of the different countries is continually raising. But you do not stop there in this task which is already so complicated. You look always towards the future.

This is the first time that I have been present with you : in consequence I am in the position of one who comes from outside and who, already struck with the depth and scope of your work, can well appreciate the marvellous organisation which you have built up, and which you maintain so devotedly.

You will certainly have noticed that the collaboration of my Administration has hitherto been slight : that is true, but, on the other hand, I can assure you that in the great work which my Administration is now undertaking, the remarkable results for which you have worked have not been forgotten.

You may, therefore, realise the spirit of my Administration towards your activities and the regard with which it hopes to receive you.

In that connection I see only one difficulty, that is, that during our meetings here, a perfect and supple machine has been operated to show us Denmark and to put us in contact with the Danish people.

Thanks to this organisation, which has always functioned so well, we have been permitted to obtain a wide view of this beautiful country and to admire the surprising qualities of its people, who are active, peaceable and happy. We should therefore like to do something similar, but I fear this will not be possible.

You will see a country which is quite different, where the countryside is certainly not so gentle as you have here, but where you may see a countryside very varied and with a special charm. The work people there, although having different qualities, are a people also peaceable, welcoming and hospitable.

Under the direction, both farseeing and attentive, of an admirable leader, these people, who had almost forgotten their former grandeur, are beginning to settle down in their new organisation, and, proud of this, are to-day ready to look others in the face. With dependencies scattered over the world and lengthy communications with all the Continents, the Portuguese people have a well-developed sense of good international understanding.

I think that the consideration of these circumstances will help considerably those who visit Portugal to understand and to love, I hope, the Portuguese people.

We will do everything possible that this may be so when you pay us the honour and give us the pleasure of coming to our country.

In tendering you the best thanks of the Portuguese Administration of Posts, Telegraphs and Telephones for the honour you have done them, I can assure you that you will be welcome. Mr. President, Gentlemen, Portugal awaits you. (Loud Applause.)

Mr. Gredsted : Ladies and Gentlemen, I sincerely thank Mr. Vaz Pinto for his kind words. We are very grateful for the invitation which he has presented to us in the name of the Portuguese Telephone Administration.

I would ask the Secretary-General to give a few explanations on the list of new questions for study by the XIth Plenary Assembly.

Mr. Valensi : Ladies and Gentlemen.—The questions of protection against interference and of protection against corrosion, the study of which the XIth Plenary Meeting has decided to undertake or to continue in 1937 and 1938, will be found in parts IV A and B of the folder which has just been handed to you. A Sub-Committee for the preparation of transmission studies for 1937 and 1938 has met ; the Minutes of this Meeting will be found included in the list of questions on transmission set for study by the XIth Plenary Meeting (Part IV C of the folder which has just been handed to you). The Minutes of the Meeting of this Sub-Committee contain all the modifications which have been made to the wording of the transmission questions which the XIth Plenary Meeting has decided to undertake or to continue in 1937 and 1938. A final list of all these transmission questions, properly numbered, will be sent by the Secretariat of the C.C.I.F. to the chief Rapporteurs of the 3rd, 4th and 5th C.R.'s for approval before being sent to Administrations and Operating Companies belonging to the C.C.I.F. ; it is this list, approved by the chief Rapporteurs, which will be included in the printed " compte rendu " of the XIth Plenary Meeting.

Part IV D of the folder which you have just received contains a list of the questions on Operating and Traffic, the study of which is to be made in 1937 ; in this list questions Nos. 9, 10 and 11 have not been put forward at open meeting ; they have been presented by a delegation to Mr. Fossion, President of the 6th and 7th C.R.'s who considered that they were interesting and might usefully be added to the previous list.

These questions were then read and approval given to their study.

Mr. Gredsted : Ladies and Gentlemen.—It is now necessary, in accordance with custom, to determine the constitution of the C.R.'s who will be called upon to study these various questions in 1937 and 1938 ; for the constitution of these C.R.'s, I would ask the Chief Delegates of the countries which desire to participate in each of the Committees, to be good enough to indicate the same. If the Chief Delegate of a country which wishes to participate in the work of a Committee is in a position to indicate the name of the delegate who will represent his Administration, he is also requested to do so.

The Meeting then appointed the Administrations and Operating Companies who wished to be represented on the C.R.'s of the C.C.I.F. in 1937 and 1938. It was decided that the Commissions of Rapporteurs should be constituted as follows :

1st C.R., entrusted with questions in regard to the protection of telephone lines against interference (Chief Rapporteur, Dr. Jäger) : Germany, Belgium, France, Great Britain, Italy, Japan, Mexico, Roumania, Sweden and Czechoslovakia, Austria (Mr. Pfeuffer), China, Poland, Portugal (Mr. J. Matos e Silva), U.S.S.R. (Prof. Lapirov-Skoblo).

2nd C.R., entrusted with questions covering the protection of cables against corrosion due to electrolysis or to chemical action (Chief Rapporteur, Mr. Collet): Germany, Belgium, France, Great Italy, Japan, Poland, U.S.S.R. (Mr. Azboukin).

3rd C.R., entrusted with certain questions of transmission and maintenance : (Chief Rapporteur, Mr. Höpfner) : Germany, Belgium, Cuba, Denmark, Spain, United States of America, France, Great Britain, Italy, Mexico, Norway, Japan, Holland, Poland, Roumania, Sweden, Switzerland, Czechoslovakia, Austria (Mr. Heider), Portugal (Mr. C. G. S. Ribeiro), U.S.S.R.

4th C.R., entrusted with certain questions of transmission (Chief Rapporteur, Mr. B. S. Cohen) : Germany, United States of America, France, Great Britain, Mexico, Poland, Japan, Cuba (Mr. Pocock), Hungary, Sweden (Mr. Swedenborg). Chili ceases to be a member of the 4th C.R.

5th C.R., entrusted with certain questions of transmission (Chief Rapporteur, Mr. Le Corbeiller) : Germany, Argentine, Denmark, Spain, United States of America, France, Great Britain, Italy, Holland, Japan, Chili (Mr. Deloraine), Poland, U.S.S.R.

6th C.R., entrusted with questions of exploitation (Chief Rapporteur, Mr. Fossion) : Germany, Belgium, Denmark, Spain, United States of America, France, Great Britain, Italy, Mexico, Japan, Norway, Holland, Poland, Roumania, Sweden, Switzerland, Czechoslovakia, China, Hungary (Dr. Havas), U.S.S.R.

7th C.R., entrusted with questions of tariffs (Chief Rapporteur, Mr. Fossion) : Germany, Belgium, Denmark, Spain, United States of America, France, Great Britain, Italy, Mexico, Norway, Holland, Poland, Roumania, Sweden, Switzerland, Czechoslovakia, Japan, Austria (Mr. Oestreicher), Hungary, (Dr. Havas), Portugal (Mr. O. Saturnino), U.S.S.R.

The Meeting then fixed as follows the constitution of the Mixed Committee for the general European toll plan :

President : Mr. Höpfner (Germany).

Members representing the Operating Services :

Mr. Ehlers (Germany).
Mr. Fossion (Belgium).
Mr. ..... (Spain).
Mr. Debry (France).
Mr. Gomm (Great Britain).
Dr. Havas (Hungary).
Mr. Halling (Sweden and other Scandinavian Countries).
Mr. Mœckli (Switzerland).

Members representing the Technical Services :

Messrs. Gladenbeck and Oehlen (Germany).
Mr. Holmblad (Denmark).
Mr. Malézieux (France).
Messrs. Timmis and Chamney (Great Britain).
Dr. Tomits (Hungary).
Mr. ..... (Poland).

Mr. McCurdy (Roumania).
Mr. Stowasser (Czechoslavakia).
Prof. Lapirov-Skoblo (U.S.S.R.).

Technical Consultant :

Dr. Osborne (A. T. & T. Co., United States of America).

Secretary : Mr. Parmentier.

The meeting was suspended for a few minutes and subsequently resumed under the presidency of Mr. Mondrup, Director-General of Posts, Telegraphs and Telephones for Denmark, who made the following speech :

Mr. Mondrup : Ladies and Gentlemen.—We have come to the moment when the documents, resulting from the work of our meeting, have accumulated in the folders of the delegates.

From the number and bulk of these documents the work carried out appears to be enormously greater than that of previous Plenary Meetings, and the new questions set for study by this meeting offer an attractive opportunity for study in the future. I give you my best wishes for this work, thanking you for the great interest which you have always evinced in the development and the perfecting of international telephony.

I must once more thank the Vice-Presidents, Colonel Lee, and Messrs. Höpfner and Muri, who have competently and efficiently directed those meetings of the Plenary Assembly devoted to questions of Protection, Transmission and Operating. I wish to thank most sincerely the members of the C.R.'s and especially the Chief Rapporteurs, who have carried out their heavy task in an excellent manner.

There still remains for me to tender my very best thanks to the Central Organisation of our Committee, the Secretariat-General, and its admirable Chief, Mr. Valensi, to his collaborators, the Secretaries, and to the personnel of the Department, for the efficient work which they have carried our during the meeting.

I thank you, Ladies and Gentlemen, for the honour which you have done my Administration in accepting this invitation to come to Denmark, and from the bottom of my heart I wish you a safe return to your respective countries. (Loud applause.)

Mr. Drouët : Mr. Director-General.—All the delegates who have taken part in this meeting of the C.C.I.F. have charged me with the very agreeable duty of asking you to thank the Danish Government on their behalf for having organised at Copenhagen our XIth Plenary Meeting, and to inform you of the recollection we shall retain of the welcome which has been given to us in Denmark.

First of all, Mr. Director-General, we feel particularly honoured that you have been good enough to accept the presidency of this meeting. You have carried out the duties with an impartiality, as well as with a cordiality, which we shall not forget.

We ask you, therefore, to accept our warmest thanks to the Administration of Posts and Telegraphs of Denmark, and to convey them to the Telephone Companies of Copenhagen, Fuen and Jutland, for the splendid receptions they have held in our honour, and for the notable excursions which they have organised to enable us to appreciate the beauties of your country.

We already knew Denmark by her noble history and the world-wide fame of Danish celebrities in Art, Literature, Science and Technique. To-day, thanks to the remarkable hospitality which you have afforded us, we have been able to appreciate, at first hand, the beauty of Denmark : we have been struck by its special charm and enchanted by the sympathetic cordiality of its warm-hearted inhabitants.

The delegates of the C.C.I.F., and all the ladies who accompanied them, have been the recipients of attentions carried out in the most kindly and charming manner by all members of the Danish Reception Committee.

In addition, we would especially ask you, Mr. Director-General, to be good enough to transmit the warmest thanks of all the delegates and their ladies to all members of the Reception Committee, and especially to all those Danish ladies, whose charm has still further embellished the rejoicings to which we have been invited.

And, above all, we express our very sincere gratitude to Mr. and Mrs. Gredsted for the kindly grace with which they have both done everything for our pleasure, and to Mr. Gredsted we offer our congratulations upon the organisation of our visit which has been such a wonderful success.

All these agreeable attentions which we have received in Denmark have helped, Mr. Director-General, to make the work lighter for all, and agreement has been easily arrived at upon the numerous questions which we had to discuss, in the atmosphere of general content in which we have been placed.

The most agreeable moments come to an end, and our stay in Copenhagen is finished, but you may rest assured, Mr. Director-General, that we shall keep a particularly impressive recollection of the Danish Plenary Meeting of the C.C.I.F.

Before we leave for our different countries, allow me, Mr. Director-General, to ask you to convey the expression of our respectful greetings to the Ministry of Public Works.

On leaving you, we wish to express our most sincere wishes for the prosperity of the Danish Administration of Posts and Telegraphs, of the various Companies which operate the telephones in Denmark, and especially of your beautiful country and its kindly inhabitants. (Loud applause.)

Mr. Mondrup : I have to thank you, Mr. Drouët, very much for the kind words you have addressed to me on behalf of all the delegates.

Mr. Valensi : Mr. Director-General, on behalf of the Secretariat of the C.C.I.F., I wish to thank you very sincerely for your kind words which I must transmit especially to the Secretaries and to the personnel of the Secretariat, who have had, particularly during the last few days, a very heavy task. As for myself, I have only done my duty and it is a great pleasure to have collaborated in the work of this meeting.

I have also the pleasant duty of thanking, on behalf of all the personnel of the Secretariat of the C.C.I.F., the Director-General and the officials of the Danish Telephone Administration for the efficient and devoted help which has been given to us. Thanks to the kindness of our Danish colleagues, our offices have been well and quickly installed and our work has been facilitated enormously. The Danish staff also have given us much assistance in the duplicating and typing work.

May I be permitted to make one more statement: the bonds of friendship have been spontaneously established among all the delegates of the C.C.I.F. from the first meeting of the Committee ; during this XIth Plenary Meeting this friendship has been more and more strengthened ; it has become so infectious that delegates present for the first time have immediately participated in it. This international friendship is certainly one of the best results of our labours. (Applause.)

Mr. Gredsted : Gentlemen, I have been very touched by the manner in which you have received the speech of Mr. Drouët, thanking my collaborators and myself on your behalf. I wish to thank Mr. Valensi very sincerely for the hearty and kindly collaboration between the Secretariat-General of the C.C.I.F. and the Reception Committee of the XIth Plenary Meeting : I can assure you, not only for myself, but also on behalf of the personnel of the Danish Telephone Administration, and of the Telephone Companies of Denmark who have taken part in the Plenary Meeting, that it has given us great pleasure to endeavour to please you during your stay here.

Personally, I may say that I am happy if I have made a return in some small way for the hospitality which during the past twenty years I have received in some of the countries represented here to-day. (Applause.)

Mr. Mondrup : Before closing the meeting I would like to add a few further remarks. The flattering remarks which we have just heard touched us very deeply, but I assure you, gentlemen, that it is a very small matter which I have been able to do for you. The most important thing, and that which offers good hope for the future, is the spirit of friendship which has reigned during our meetings here.

Gentlemen, I thank you all in bidding you " au revoir," and I declare the XIth Plenary Meeting of the C.C.I.F. closed. (Long Applause.)

The meeting closed at 4 p.m.

COMITE CONSULTATIF INTERNATIONAL TELEPHONIQUE

XIth Plenary Meeting, Copenhagen, 11th—20th June, 1936.

PART I.

PROTECTION OF TELEPHONE LINES AGAINST THE INTERFERING EFFECT OF HEAVY CURRENT OR HIGH TENSION POWER SYSTEMS.

Recommendations of the C.C.I.F.

Recommendation No. 1.

Guiding Principles concerning the measures to be taken to protect telephone lines against the interfering effects of heavy current or high tension systems.

The International Telephone Consultative Committee—

Unanimously recommends :—

That for the protection of international telephone circuits against interference due to neighbouring power lines or electric traction systems, it is desirable to apply the methods contained in the 1930 edition of the " Guiding Principles concerning measures to be taken in order to protect telephone lines against the disturbing influences of heavy current or high tension power lines."

Considering however :—

That since the publication of the 1930 edition many studies have been carried out—by the C.M.I. in particular—on the interference in telephone lines caused by near-by power lines and that important new facts have been noted.

That taking these facts into account the Xth Plenary Meeting (Budapest 1934) has taken advantage of the results obtained at that time in order to complete or modify in certain respects the text of the 1930 edition of the Guiding Principles.

That in consequence a Special Committee, purposely limited in number in order to accelerate their work, was formed in 1934 to prepare a new edition of the Guiding Principles which would take into account the progress made since the previous edition was issued. This Committee consists of the Chief Rapporteur of the 1st C.R. and one representative or the 1st C.R. from the Telephone Administrations of Germany, France, Great Britain and Sweden. In addition the following international organizations—International Electrotechnical Commission—C.I.G.R.E., International Railway Union, International Union of Electrical Power Producers and Distributors—have been invited to participate in the work of this Committee and have, in fact, sent delegates for that purpose.

That from its earliest meetings this Committee has realised that some of the modifications to be made to the 1930 edition affected some of the principles of that document and that without having been able to draw up a complete revision of this document the Committee has, in the course of its work, decided upon the modifications of principle required.

That such modifications require approval by the Plenary Meeting.

Unanimously recommends :—

That in drawing up the new edition of the Guiding Principles the Revision Committee should be guided by the principles given in the Note which follows.

That the first examination of contributions to this new edition which some members of the Committee have undertaken should be made at a meeting of the Committee to be held in the spring

of 1937, so that, within a short time a complete new draft may be submitted to the Administrations and Operating Companies belonging to the C.C.I.F. for their observations, the definite approval being then obtained at the next plenary meeting.

NOTE

CHIEF MODIFFICATIONS TO BE MADE TO THE GUIDING PRINCIPLES (1930 EDITION).

I. Form in which " Guiding Principles " should be published.

In general, the form of the 1930 edition will be maintained though slight differences will be made in the type, colour of paper, etc., used for the " Guiding Principles " properly speaking and also the rules to be followed in ascertaining the conditions under which proximity of power and telephone lines can be admitted, and that used for the explanatory and documentary matter. For instance, the two first parts will be printed in large type on white paper whereas the annex will be printed in small type on coloured paper.

Consideration is also being given to the inclusion, between the rules and the annex, of numerical examples of typical cases.

II. Mutual Inductance.

In the calculations a value M of mutual inductance will be used which is more exact than that used in the past and which takes more into account the earth conductivity and also the shielding effect of any metallic conductors present (screens, sheaths, etc.).

(*a*) Earth Conductivity.

With regard to the earth conductivity — having taken into account the conclusions of the IVth Plenary Meeting of the C.M.I., a table will be introduced of the various values of actual conductivity (homogeneous earth) or of the apparent conductivity (heterogeneous or stratified earth) at 50 p:s and 800 p:s which have been determined for various countries, with an indication of the geological constitution of the earth.

The work of the C.M.I. shows that the general idea of apparent conductivity in the case of a non-homogeneous earth may be preserved but that the information given in the Guiding Principles both as concerns the value of this apparent conductivity and its variation as a function of frequency, should be revised.

In the case of stratified earth consisting of an upper layer of depth h of conductivity σ_1, and an infinite and homogeneous adjacent sublayer of conductivity σ_2 it would appear possible and profitable to include in the Guiding Principles diagrams which allow of estimating the apparent conductivity σ of the stratified earth as a function of the three parameters h, σ_1, σ_2 and of the frequency f.

(*b*) Shielding effects.

Account will be taken, in calculating the mutual inductance M as closely as possible, of the shielding effects of any metallic conductors present such as wires, screens, cable sheath of power or telecommunication cables, railway lines, etc.

III. Short-circuit Current.

In the text of the 1930 edition, the Guiding Principles properly speaking indicated a presumption of danger when during the very brief time required to operate a circuit-breaker on a power line suffering from a short-circuit, the conductors of the telephone line are submitted to an inductive electromotive force of over 300 volts effective, after disappearance of the transitory phenomena.

It was also indicated, in evaluating the E.M.F. due to magnetic induction, that the value of the permanent short-circuit current compatible with the characteristics of the power line should be taken into account.

An endeavour was made to define the significance to be given to the expression *permanent short-*

circuit current in the following terms " By short-circuit current is understood the effective permanent current which passes between the line and earth, when an accidental earth occurs, after the surge caused by the short circuit has been dissipated." (See 1930 Guiding Principles page 17, 4th paragraph.)

This definition has been variously interpreted ; in some cases it has been taken that the value of short-circuited current to be used was the value of the alternating current after the disappearance of all transitory phenomena.

On the other hand in the opinion of certain of the compilers of the Guiding Principles, the value to be taken into consideration is that of the alternating component of the current at the moment when the aperiodic component has practically been dissipated (which it was felt would be reached at the end of two or three periods). This interpretation has been adopted by several countries. It is justified by the fact that :—

(1) The value of alternating voltage induced on the telephone line is always proportional to the value of the alternating component of the disturbing current.

(2) That the risk of acoustic shock or other accident appears as early as the first alternation.

It is now well known that only the alternating component of the instantaneous short-circuit current can be defined and calculated with precision. The representatives of the electrical industry accordingly have asked that only this value should be taken into consideration in the calculations and, based on the idea that there is no need to increase the severity of the conditions of application of the Guiding Principles, would be done by applying this rule and maintaining a limiting value of 300 V for the induced E.M.F., they have requested that in the calculation made on the new basis a higher limit should be specified.

In support of this request, it is argued that the telephone authorities of countries in which the value of the induced E.M.F. has been calculated from the alternating current value after a sufficiently long interval, have made no request that the conditions under which coexistence is permitted should be made more strict.

The representatives of the telephone authorities are inclined to consider this request in some degree, especially on the assumption that in future the protective devices used on telephone lines will be sufficiently improved to reduce the probability of danger. Without modifying the 300 V limit, a fraction of 7/10 of the value of the alternating component of the short-circuit current will be adopted as the value of the disturbing current.*

A special appendix will summarize the fundamental principles upon which certain methods of calculating the short-circuit current are based. Mention will be made of the fact that if devices used for limiting the neutral current (impedance between neutral and earth, Petersen coil, etc.) exist on the power line, they will be taken into account in calculating the short-circuit current.

IV. Earthing the Neutral.

With reference to induced noise, the earthing of the neutral does not usually cause any increase, if each of the transformers having the neutral point earthed, has at least one delta winding of suitable size or if the connections are such that the circulation of the harmonics along lengths of parallel sections is avoided.

V. Telephone Equipment.

The Guiding Principles will state that in those cases where the telephone authorities consider that it would be possible to place special devices (for example repeating coils) on an open wire telephone circuit subject to disturbance from a neighbouring power line, this can be taken into account.

---

* See Recommendation No. 3.

VI. Unbalances.

(*a*) Unbalance to earth.

For periodic maintenance the state of the balance to earth of telephone circuits will continue to be checked in accordance with the methods described on page 51 of the Guiding Principles (English edition, p. 53) or on page 140 of Vol. IV of the White Book (English edition, p. 419).

The effect of the termination at the far end of the circuit of which the unbalance is being checked, should be studied. It will be stipulated that this check should in general be made at 800 p : s and that it may also be made at other frequencies. Definitions of and theoretical explanations as to the interpretation of the results of these tests will not continue to be given in the Guiding Principles.

(*b*) Coefficient of Sensitivity (Noise Ratio).

In accordance with Recommendation No. 7 (Protection) of the Xth Plenary Meeting there will be introduced into the Guiding Principles a new conception of coefficient of sensitivity (noise ratio) of a circuit, which is concerned with the relationship between the psophometric E.M.F. of a circuit and the longitudinally weighted E.M.F. The determination of values for this sensitivity coefficient (noise ratio) is dependent upon the results of tests now being made by the C.M.I.

VII. Psophometric Voltage and Telephone Form Factor.

The following new definitions will appear in the Guiding Principles in substitution of those which appear on pages 7 and 8 of the present Guiding Principles (English edition, p. 11). In addition the specification of the Psophometer will be included as an annex showing the principle upon which this apparatus has been based. General information will also be given on the measurement of the equivalent disturbing voltage.

(*a*) By definition the *psophometric voltage between any two points* of a telephone system is given by the expression :—

$$\frac{1}{p_{800}} \sqrt{\Sigma (p_f V_f)^2}$$

in which V_f is the disturbing voltage of frequency f.

p_f is the weighting value given to this frequency.

This psophometric voltage corresponds to that voltage which at 800 p : s would cause the same interference to conversation when applied to the telephone line as does the disturbing voltage.

The *psophometric E.M.F.* at the end of a telephone circuit is double the psophometric voltage which would be measured at the terminals of a 600 ohms pure resistance by which the line would be closed at one end (testing point) or across a suitable transformer, whilst the other extremity of the circuit was closed by its characteristic impedance.

The *psophometer* is an apparatus giving a direct reading of the value of the psophometric voltage between the points to which it is connected, and having a high input impedance.

(*b*) By definition *the equivalent disturbing voltage* of a power line is given by the expression :—

$$\frac{1}{p_{800}} \sqrt{\Sigma (k_f p_f V_f)^2}$$

Where :—

V_f is the service voltage at frequency f.

p_f is the weighting value for this frequency.

k_f is a factor, as a function of the frequency, taking into account the conditions of coupling of the lines concerned as well as the working conditions of the power line (see below).

This equivalent disturbing voltage corresponds to the voltage at 800 p : s which when applied to this line would produce on a neighbouring telephone line the same trouble as does the service voltage.

(*c*) The *equivalent disturbing current* of a power line is defined in a similar manner by the expression

$$\frac{1}{p800}\ \sqrt{\Sigma\ (h_f\ p_f\ I_f)^2}$$

Where :—

I_f is the current at the frequency f which causes the interference.

h_f is a factor similar to the factor k defined under disturbing voltage (see below).

(*d*) *The telephone form factor of the voltage* of a power line or network is the ratio, expressed as a percentage, between the equivalent disturbing voltage and the operating voltage.

Coupling.

According to the kind of system and the nature of its effect on the telephone line, either the equivalent disturbing voltage or the equivalent disturbing current must be taken into account and the factor k_f must have a value of either $\frac{f}{800}$, 1, or $\frac{800}{f}$, and the factor h_f must have a value $\frac{f}{800}$ or 1.

The choice of the value to be given to these factors k or h can now be determined in the following cases :—

1. *Open Wire Telephone Lines*

— disturbing voltage of a high tension power line, in the case of electric induction $k_f = \frac{f}{800}$

— disturbing voltage of a traction power line, in the case of magnetic induction $k_f = 1$

— disturbing current of a traction power line, in the case of magnetic induction $h_f = \frac{f}{800}$

2. *Telephone Lines in Cable*

— disturbing voltage of a traction power line, in the case of magnetic induction $k_f = \frac{800}{f}$

— disturbing current of a traction power line, in the case of magnetic induction $h_f = 1$.

VIII. Electric Induction.

Following the work of the C.M.I. the Guiding Principles will be completed by considering the relative transpositions of power lines and telephone lines, when the operating voltage of the power line is 150 kV or more.

This will be taken into account in completing the calculations for operating troubles (pages 14 and 15 of the 1930 edition paras. C.1 and C.2 English edition, pp. 17 and 18). On the other hand this induction will be neglected in the calculations of the exposure to danger.

Recommendation No. 2.

Use of electrostatic formulae for determining the electric induction from an alternating current line in a telephone circuit.

The International Telephone Consultative Committee—

Considering :—

That it follows from special investigations of this subject that the effect on the determination of the capacity coefficients of the distribution of the current in the earth is entirely negligible at industrial and telephone frequencies,

Unanimously recommends :—

That there is no reason to modify the development contained in the " Guiding Principles " on the subject of the calculation of electric induction of a power line in a telephone circuit, a development which makes use of electrostatic formulae.

Recommendation No. 3.

Calculation of the effects caused by short-circuit current.

The International Consultative Telephone Committee—

Considering :—

That the information contained in the 1930 edition of the Guiding Principles relative to the value of the intensity of the short-circuit current to be used in calculating mutual inductance, has in practice been variously interpreted.

That it has been admitted that the alternating component only of the instantaneous short-circuit current, can be precisely determined and calculated.

That it appears possible in accordance with the ideas contained in the annex to Recommendation 1 bis to include in the calculation a value for the inducing current which is approximately 7/10 of the value of this alternating component.

Recommends :—

That in the application of the rules of the Guiding Principles the alternating component of the instantaneous short-circuit current should now be included.

That without modifying the limit of 300 V, a value of inducing current of 7/10 the value of the alternating component should be adopted.

That it is unnecessary to apply this reduction when the limit of induced voltage is given as a function of the dielectric of telephone cables and their associated equipment.

Recommendation No. 4.

Psophometric voltage. Psophometric E.M.F. Equivalent disturbing voltage. Equivalent disturbing current. Telephone form factor of the voltages.

The International Telephone Consultative Committee—

Considering :—

That certain definitions given in the 1930 edition of Guiding Principles and in the C.C.I.F. White Book (Vol. II, pages 7 and 8 English edition, p. 114) may be difficult to interpret.

That it is possible to express these definitions in a simpler and more general manner.

That these new definitions are more suitable for use in calculations and in objective measurements.

Recommends :—

That the following definitions should be adopted forthwith.

(*a*) By definition the *psophometric voltage between any two points* on a telephone system is given by the expression

$$\frac{1}{p_{800}} \sqrt{\Sigma (p\ V)^2}$$

in which V_f is the disturbing voltage of frequency f.

p_f the weighting value given to this frequency.

This psophometric voltage corresponds to that voltage which at 800 p : s would cause the same interference to conversation when applied to the telephone line as does the disturbing voltage.

The psophometric E.M.F. at the end of a telephone circuit is double the psophometric voltage measured at the terminals of a pure 600 ohms resistance by which the line would be closed at one end (testing point) or if necessary across a suitable transformer, while the other end of the line would be closed by its characteristic impedance.

The psophometer is an apparatus giving a direct reading of the psophometric voltage between the points to which it is connected, and having a high input impedance.

(*b*) By definition the *equivalent disturbing voltage of a power line* is given by the expression :—

$$\frac{1}{p800} \sqrt{\Sigma (k_f p_f V_f)^2}$$

where :—

V is the service voltage at frequency f.

p_f is the weighting value for this frequency.

k_f is a factor, as a function of the frequency, taking into account the conditions of coupling of the lines concerned as well as the working conditions of the power line (see below).

This equivalent disturbing voltage corresponds to the voltage at 800 p : s which when applied to this line would produce on a neighbouring telephone line the same trouble as does the service voltage.

(*c*) *The equivalent disturbing current* of a power line is defined in a similar manner by the expression

$$\frac{1}{p800} \sqrt{\Sigma (h_f p_f I_f)^2}$$

I_f is the current at the frequency f which causes the interference.

h_f is a factor similar to the factor k defined under disturbing voltage.

(*d*) *The telephone form factor of the voltage* of a power line or network is the ratio, expressed as a percentage between the equivalent disturbing voltage and the operating voltage.

Recommendation No. 5.

Objective measurements of line noise.

The International Telephone Consultative Committee—

(1) *Considering :—*

That it is more and more necessary to have an instrument for the objective measurement of psophometric E.M.F. which shall be adopted for a long period by all the Administrations and private operating companies ;

That, in addition, the provisional characteristics fixed for this instrument in the recommendation of the Plenary Meeting of Paris, 1931, have enabled experimental apparatus to be set up, and that more recent tests have led to a greater precision in the requirements which this instrument must satisfy,

Unanimously recommends :—

That from now on the psophometric E.M.F. as defined above, should be measured by means of a psophometer fulfilling the conditions of the Note below.

(2) *Considering :—*

On the other hand, that in all cases where it is a question of determining whether the noise in a line exceeds a permissible limit, it appears preferable, in order to obtain perfectly comparable results which will be more easily interpreted, to make these measurements directly on the line without bringing in the individual characteristics of the other lines and apparatus connecting it to the subscriber's receiver.

Unanimously recommends :—

That in the cases considered above, it is desirable to make the measurements using a psophometer having the characteristic weighting curve defined below (psophometer for commercial telephone circuits) without using any auxiliary circuit model.

The instructions for the use of the apparatus are also given in part II of the Note below.

(3) *Considering :—*

Finally, that the interfering effect in lines is different according to whether it is a question of commercial telephone or of radio programme transmission so that it is impossible to use the same apparatus in the two cases.

Unanimously recommends :—

That it is necessary to distinguish clearly these two questions and to have re-examined by the 3rd, 4th and 5th C.R.'s the weighting curve for use with special circuits for radio programme transmission* in order to adapt the curve to the present technical requirements of these circuits.

NOTE.

SPECIFICATION OF THE PRINCIPLE AND METHOD OF USE OF PSOPHOMETERS EMPLOYED ON COMMERCIAL TELEPHONE CIRCUITS.

I. Specification of Principle.

(*a*) Weighting curve.

Table I below and the attached curves give, under the heading of weighting factor, the relative values of average interfering effect of different frequencies when the value of the real voltage at each frequency at the terminals of a receiver is the same.

Each weighting factor is given with respect to the corresponding weight at 800 p : s. Opposite each relative value are given corresponding values in nepers and decibels.

The psophometer should contain a filter network associated with a measuring instrument. Its characteristics are such that if to the input terminals of the psophometer is applied an alternating voltage whose amplitude remains constant whatever the frequency, the value given by the instrument shall be proportional to the relative weighting factor of the frequency in question.

The characteristics should depart as little as possible from the values given in Table I so that the deviations do not exceed the permissible limits specified in Table II.

The characteristics of the psophometer shall be as stable as possible under practical operating conditions, i.e. in spite of transport, changes of temperature, etc.

(*b*) Measuring instrument.

The measuring instrument should be graduated† so that when a voltage at 800 p : s is applied to the input terminals of the psophometer the reading of the instrument is equal to the applied voltage.

In the case of a mixture of frequencies, the reading of the instrument should be equal to the square root of the sum of the squares of the readings corresponding to each component if it existed alone.

(*c*) Input impedance.

For the whole band of frequencies from 15 to 5 000 p : s the input impedence of the psophometer should be as large as possible and in any case at least 10 000 ohms.

---

* See Part 4 of Volume IV of the White Book, 1935.

† See page 122 of Vol. I of the White Book, 1935, the table correlating the calibration given in the specification of the C.C.I.F. for the psophometer (on the one hand), and the calibration used in the psophometer of the A. T. & T. Co. (on the other hand). Page 79 English Edition, 1934.

TABLE I

Table of weighting factors.

(*See Figs. 1 and 2 on p. 37.*)

Frequency	Weighting Factor.		
	Relative Values.	Neper.	db.
16.7	0.115	—9.07	—78.8
50	2.48	—6.00	—52.1
60	4.10	—5.50	—47.7
100	15.0	—4.20	—36.5
150	46.0	—3.08	—26.7
180	80.0	—2.53	—21.9
200	105.0	—2.25	—19.6
300	300	—1.20	—10.5
400	400	—0.92	— 8.0
500	472	—0.75	— 6.5
600	560	—0.58	— 5.0
700	705	—0.35	— 3.0
800	1000	0.00	0.0
900	1405	+0.34	+ 3.0
1000	1840	+0.61	+ 5.3
1050	1880	+0.63	+ 5.5
1100	1770	+0.57	+ 5.0
1200	1260	+0.23	+ 2.0
1300	795	—0.23	— 2.0
1400	527	—0.64	— 5.6
1500	419	—0.87	— 7.6
1600	353	—1.04	— 9.0
1800	289	—1.24	—10.8
2000	254	—1.37	—11.9
2200	225	—1.49	—13.0
2400	200	—1.61	—14.0
2600	177	—1.73	—15.0
2800	159	—1.84	—16.0
3000	141	—1.96	—17.0
3500	80.0	—2.53	—21.9
4000	45	—3.10	—26.9
5000	19	—3.96	—34.4

Note.—The relative values above should be taken as the basis, the corresponding values in neper and db. are approximate.

TABLE II—LIMITS.

50 and 60 p : s	... ...	± 2 decibels or	± 0.23 neper.
60 to 150 ,,	... ...	± 3 ,,	± 0.35 ,,
150 ,, 400 ,,	... ...	± 2 ,,	± 0.23 ,,
400 ,, 800 ,,	... ...	± 1 ,,	± 0.12 ,,
800 ,,	... ...	0 ,,	0 ,,
800 ,, 1800 ,,	... ...	± 1 ,,	± 0.12 ,,
1800 ,, 3000 ,,	... ...	± 3 ,,	± 0.35 ,,
3000 ,, 5000 ,,	... ...	± 5 ,,	± 0.58 ,,

In addition the maximum ordinate of the curve shall be between 1000 and 1100 p : s.

A non-reactive resistance of 600 ohms is provided so that where necessary it can be connected across the input terminal of the set.

(*d*) **Sensitivity.**

The psophometer should enable a clear reading to be obtained when an 800 p : s voltage of at least 0.05 mV is applied to the input. It should also permit a direct reading of voltages up to at least 100 mV. For the whole range of the scale and for all frequencies the readings of the apparatus should be proportional to the amplitude of the applied voltage.

(*e*) **Calibration.**

The psophometer includes an arrangement which enables the gain of the amplifier to be adjusted to the desired value before each series of tests with an accuracy of at least 5 per cent.

(*f*) **Special conditions of construction.**

Balance. The balance of the psophometer with respect to the frame should be as good as possible. In any case, the application of a voltage of 200 V at 50 p : s, a voltage of 30 V at 300 p : s, or a voltage of 10 V at 800 p : s, between the short circuited input terminals and the frame should not give a reading greater than 0.05 mV.

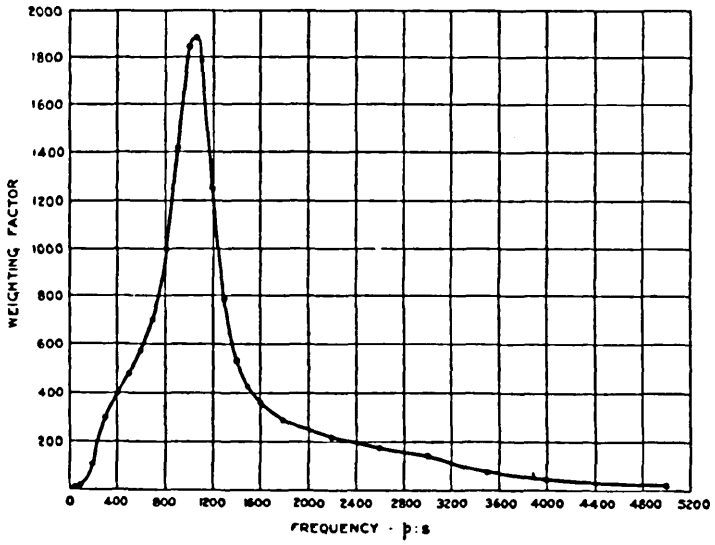


FIG. 1.

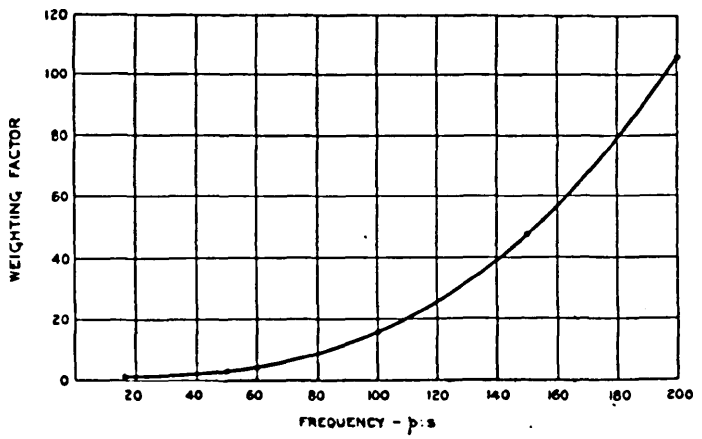


FIG. 2.

Relative values of the average interfering effect at different frequencies when the value of the real voltage at each frequency at the terminal of a receiver is the same.

Freedom from effect of external fields. The freedom from the effect of external fields should theoretically be absolute.* For this reason the psophometer and associated battery boxes should be shielded and all the shields should be provided with terminals so that they can be earthed during use. Shielded conductors should also be used for the various external connections of the psophometer.

* For example a psophometer has been made for which the reading was 0.8 mV per oersted of external field, the psophometer being turned in such a direction that the effect of the field was a maximum. (The psophometer was placed 1 metre from a cable carrying a current of 10A at 300 p : s.)

Weight. The apparatus should be portable and its weight as small as will permit the above conditions to be fulfilled.

II. Method of Use.

(*a*) When it is desired to determine whether the noise produced in a circuit exceeds a permissible limit, the measurement of psophometric E.M.F. should be made on the line itself without the use of any additional device to take account of the individual characteristics of the circuits and apparatus connecting the subscriber's receiver.

(*b*) For the measurements the circuit should be closed through 600 ohms, an inequality ratio transformer being used where necessary to match the impedance of the line to 600 ohms. Under these conditions, the psophometric E.M.F. has a value twice the reading of the measuring instrument.

(*c*) For the measurement the various shields of the apparatus and associated leads should be earthed.

(*d*) The position and orientation of the psophometer should be chosen so as to reduce as far as possible the effect of external fields.

Recommendation No. 6.

Technical information on the psophometers at present in use.

The International Telephone Consultative Committee—

Considering :—

That the recommendation entitled " Objective measurement of line noise " definitely fixed the characteristics of the psophometer, and that the Administrations and private Operating Companies are actually constructing these instruments ;

That it will be of interest to draw up a list of technical details of the operating and constructional features of these instruments,

Unanimously recommends :—

That it is desirable for the Administrations and private Operating Companies to communicate to the C.C.I.F. the required information in accordance with the following questionnaire, accompanying it with a schematic.

Operating and constructional details of existing psophometers.

Sensitivity :— 800 p : s voltage at input of psophometer giving (*a*) the maximum reading of the measuring instrument. (*b*) the first reading clearly visible.
Nature and number of parts used ... { Inductance coils. Transformers. Condensers. Vacuum tubes.
Overall dimensions (cm).
Weight (kg).
Supply voltage (V).
Current drain (A).
Input impedance (ohms).
Sensitivity to external fields. Reading of the instrument for each oersted of external field strength at 300 p : s when the apparatus is oriented with respect to the field so that the deviation is a maximum.
Balance. Reading of the instrument when the following voltages are applied between the short-circuited input terminals of the set and the frame :— a voltage of 200 V at 50 p : s. „ „ 30 V at 300 p : s. „ „ 10 V at 800 p : s.

Operating & Constructional details of existing psophometers—*contd.*

Exact shape of the characteristic curve of the apparatus :—to be given as a separate sheet, a linear frequency scale being used and the weighting factors being given on a logarithmic scale in terms of the 800 p : s value.
Maximum deviation between the ordinates of the curve and those of the standard C.C.I.F. curve. (The negative sign indicating that the psophometer gives a smaller weight than that of the standard curve) :— from 16⅔ to 60 p : s. „ 60 „ 150 „ 150 „ 400 „ 150 „ 1050 (for 800 p : s the deviation is zero) „ 1050 „ 1800 „ 1800 „ 5000
Method of calibration.

Recommendation No. 7.

Objective measurement of equivalent interfering voltage.

The International Telephone Consultative Committee—

Considering :—

That in accordance with the definition of equivalent interfering voltage, the weighting factor for each frequency is exactly the same (apart from the coupling factor) as that used in the definition of psophometric E.M.F.

Unanimously recommends :—

(1) That it is desirable, in principle, to measure the equivalent interfering voltage (or equivalent interfering current) by means of a psophometer connected to the line or power system (whatever the nature) by means of a device simulating the characteristics of the coupling between the given power line and the telephone line.

(2) That in practice a single instrument can be used for this measurement giving indications identical with those which would be given by the arrangement just described in the first paragraph.

Recommendation No. 8.

Calculation of the psophometric E.M.F. due to ripples in the case of continuous current traction lines.

The International Telephone Consultative Committee—

Considering :—

That is has been possible to define precisely the parameters which occur in the calculation of the psophometric E.M.F. due to ripples in continuous current traction lines,

Unanimously recommends :—

That this calculation can be made as is an ordinary calculation of induced voltage when the following values (referred to 800 p : s) are known :—

(1) The equivalent disturbing voltage of the traction system.

(2) The impedance of the traction system.

(3) The coefficient of mutual induction between the traction line and the telephone line in question (by this is meant either the mutual inductance between two lines with earth return, or the mutual inductance between one traction line with earth return on the one hand, and the loop of a non-transposed telephone line on the other).

(4) The shielding effect of the rail current, and, if the telephone line is in cable, the shielding effect of the current in the sheath.

(5) A value representing the noise ratio of the type of line in question, assuming that the mutual induction between two lines with earth return is in question. In some cases to calculate the psophometric E.M.F. it may be necessary to know the value of the localised unbalance of the telephone line.

Recommendation No. 9.

Distributed unbalance of a telephone line with respect to earth ; noise ratio (coefficient de sensibilité).

The International Telephone Consultative Committee—

Considering :—

(1) That the study of the idea of " impedance unbalance with respect to earth " (as defined on page 47 of the " Guiding Principles ") has shown that, in general, it is not possible to establish a direct relation between the psophometric E.M.F. and the values of this unbalance as measured at the end of the circuit ;

(2) That it is nevertheless useful to retain this simple idea which enables the state of the circuits to be appreciated approximately from the point of view of installation and maintenance.

(3) That, furthermore, it is desirable to study :

(*a*) whether for different frequencies there exists a statistical relation between the longitudinal E.M.F. and the difference of potential which is produced at the end of the circuit by the unbalances when the circuit is closed through its characteristic impedance and when no transverse E.M.F. is induced in the circuit.

(*b*) whether it is possible, in addition, to establish a statistical relation between the psophometric E.M.F. and the weighted longitudinal E.M.F.

Unanimously recommends :—

(1) That for the maintenance of circuits it is desirable to retain the definition and methods of measurement of " impedance unbalance with respect to earth " as given in the " Guiding Principles."

(2) That a new idea of noise ratio (coefficient de sensibilité) should be introduced, which relates to the ratio between the psophometric E.M.F. and the weighted longitudinal E.M.F.

Note.—In this connection the work of the 7th Comité d'Etudes of the 1st section of the C.M.I. should be taken into consideration.

Recommendation No. 10.

Localised unbalance with respect to earth.

The International Telephone Consultative Committee—

Considering :—

That in the case of short lines the unbalance to earth of the line itself is generally negligible in comparison to the unbalances in the terminal apparatus and that it is possible to put forward a new definition of localised unbalance which enables a direct calculation of psophometric E.M.F. when the weighted longitudinal E.M.F. is known,

Unanimously recommends :—

That for this particular case the following definition should be adopted. Having given a circuit with telephone apparatus at each end, a first test is made by applying to each of the wires an E.M.F., E, at telephone frequency. If the circuit is not perfectly balanced a voltage e appears across the receiver of the telephone set. In a second test a symmetrical E.M.F., E^1, of the same frequency is applied in the metallic circuit, adjusted so that the voltage across the receiver is e as before.

The degree of localised unbalance with respect to earth is, for the frequency in question, the ratio

$$\delta = E^1/E$$

The same method can be used in the laboratory to determine the unbalance of terminal apparatus independently of the line.

Note.—In order to carry out this measurement it is convenient to use the following circuit (Fig. 2a), consisting of a three winding transformer of which the two secondary windings have a small impedance and are perfectly balanced with respect to the primary. The reversal of the connections to one of the secondary windings enables the second test to be made (Fig. 2b).

From the value of the current in the primary winding the degree of localised unbalance is deduced from the formula :—

$$\delta = E^1/E = 2i^1/i,$$

It is unnecessary to use a voltmeter to measure the equality of the voltages across the receiver in the two tests ; this equality can be determined aurally with sufficient precision.

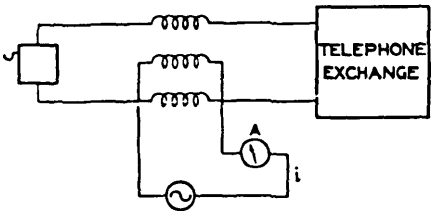


FIG. 2a.

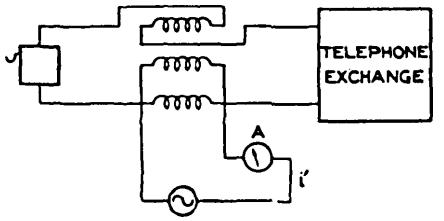


FIG. 2b.

Recommendation No. 11.

Reduction of the disturbing voltage of rectifiers.

The International Telephone Consultative Committee—

Considering :—

That it is possible to obtain a substantial reduction in the disturbing voltage of traction lines supplied by rectifiers by the use of a choke coil in conjunction with resonant shunts.

That, in any case, this device is more cumbersome and is not perhaps sufficient to suppress all the frequencies,

Unanimously recommends :—

That, so far as the reduction of the disturbing voltage of rectifier installations is concerned, devices comprising a choke coil in conjunction with resonant shunts are recommended for use.

That for six-phase rectifiers it seems desirable to design the characteristics of these shunts so as to reduce the disturbing voltage as far as is technically possible to at least one-tenth of the value it would attain if no resonant shunts were used.

Recommendation No. 12.

Tests in connection with rectifiers.

The International Telephone Consultative Committee—

Considering :—

That rectifiers with or without grid control can cause serious audible interference not only on telephone circuits which parallel the rectified current lines but also in telephone circuits near three-phase lines supplying the rectifiers ;

That Administrations and Operating Companies are very greatly interested in knowing accurately the special properties of grid-controlled rectifiers from the point of view of their effect on telephone transmission before this new type of apparatus is applied extensively in practice,

Unanimously recommends :—

That Administrations and private Operating Companies should get into touch with the professional organizations of the industry and electrical distribution of their countries so that they may profit by all opportunities of testing this type of installation to complete the information already received on this subject (refer specially to documents entitled C.C.I.F. 1934, 1st C.R. Document No. 19 and Document No. 22) and to draw from it conclusions therefrom on the normal limiting values of telephone voltage form factor.

Recommendation No. 13.

Effect of transpositions in a power line.

The International Telephone Consultative Committee—

Considering :—

That the diminution of the disturbing effect of the residual components of the various harmonics of alternating voltages and currents, obtained by means of transpositions according to the methods described in the " Guiding Principles," depends on numerous factors, such as the wave form of the generator, the length of the line, the type and arrangement of transformers, etc. ;

That, consequently, a theoretical study of this complex problem does not appear to lead to results of practical utility ;

That, on the other hand, it appears, from studies made in the United States of America, that omitting the transposition at the point where two complete rotations (barrels) should coincide would tend to reduce the residual voltages and currents.

Unanimously recommends :—

That there appears to be no inconvenience caused by omitting that transposition ;

That, concerning the problem as a whole, it does not seem opportune to undertake new investigations on this subject.

Recommendation No. 14.

Devices for protecting operators against acoustic shock.

The International Telephone Consultative Committee—

Considering :—

That, from the point of view of the protection of operators against acoustic shock, three types of apparatus have been discovered which are particularly suitable (these are : coherers, arrangements of rectifying elements, arrestors associated with voltage transformers) ;

That there is little difference in the sensitivity of these devices but that the method of use is somewhat different ;

That the study of coherers can be considered as finished, and furthermore, that a long experience has been obtained of their use in service which shows that they give good results, on the condition, however, that they are vigilantly maintained ;

That the preliminary studies and tests in service of arrangements of rectifying elements and arrestors with transformers have given very encouraging results, that these devices appear to require little maintenance and that, in particular, arrangements of rectifying elements are in actual service in certain networks,

Unanimously recommends :—

(1) That it is unnecessary to carry out comparative studies on coherers.

(2) That in connection with arrangements of rectifying elements, it is desirable to collect results

of actual practical tests obtained in networks where they are in service with a view to discovering what are their best conditions of use.

(3) That in connection with arrestors with transformers, it is desirable to continue the tests in order to determine the results that can be obtained with them.

Recommendation No. 15.

Earthing a Long-distance Telephone Circuit in a Cable.

The International Telephone Consultative Committee—

Considering :—

That, in the present state of the art, cables are made with extremely low unbalances between the various circuits and earth, particularly so with respect to the circuits in the inside layers of the cable.

That these unbalances are sufficiently low if the circuits are not to be earthed.

That, on the contrary, each earthing—even with apparent symmetry—involves a risk of bringing into play inductance and resistance unbalances for each circuit which is earthed.

That the dielectric strength between two conductors in a cable is considerably lower than that between the conductors and the lead sheath, and therefore, the earthing of certain circuits is apt to cause a risk of breakdown of the dielectric between the conductors when the cable is exposed to serious induction effects.

That, when the cable is subjected to an induced voltage of considerable magnitude, the presence of an earth allows currents to flow with an amplitude which in some cases exceeds the limit which may be permitted in order to maintain the good magnetic quality of the loading coils.

Unanimously recommends :—

1. That it is recommended not to earth a circuit in a long-distance cable at any point.

2. That, as a general rule, it is recommended not to earth any point of an installation (telephone or telegraph), which is metallically connected to a long-distance cable circuit.

3. That, in all cases, where special reasons demand the earthing of an installation which is directly connected to the conductors of a cable, the following precautions should be taken :—

(*a*) The earthing should be done so as not to interfere with the balance of the circuits with respect to earth or neighbouring circuits.

(*b*) The breakdown voltage of all the remaining conductors of the cable with respect to the earthed circuit should be appreciably greater than the highest voltage which, by reason of the induction of neighbouring power lines, may be present between these conductors and the earthed circuit.

(*c*) When a telegraph installation is connected to a cable the prescriptions of the C.C.I.F. on the subject of co-existence of telegraphy and telephony on the same circuit should also be observed.

Recommendation No. 16.

Connection of a Public Telephone System to Telephone Circuits Associated with Power Installations.

The International Telephone Consultative Committee—

Considering :—

That distributors of electric energy require connections between circuits suspended on pole lines or in cables of the public telephone system and carrier frequency circuits superimposed on the high tension conductors or ordinary telephone circuits, suspended on the high tension poles.

That, if such arrangements are allowed, every precaution should be taken absolutely to prevent dangers arising from any derangement of the coupling devices between the lines.

That experience in certain countries for over ten years has shown what precautions should be taken.

Unanimously recommends :—

That from a technical standpoint it appears possible to permit these connections being made, provided the installations conform to the prescriptions given below.

These prescriptions are in two parts : one covers the case of telephone lines carried on the same pole as the high tension line ; the other applies to carrier circuits superimposed on high tension lines.

I. Conditions to be Fulfilled in Cases where a Telephone Line, L_1, Carried on the Poles or in the Cables of a Public Telephone Network, is Connected to an Ordinary Telephone Line, L_2, Suspended on the High Tension Line Poles.

(*a*) The coupling devices between the two telephone Lines L_1 and L_2 should conform to the best practices of the art.

(*b*) In the event of contact between the high tension conductors and the wires of line L_2 the possibility of high tension current entering the telephone line L_1 should be satisfactorily eliminated by the coupling device, which should, generally, be equipped with an insulating transformer, lightning protectors and fuses of sufficient capacity.

(*c*) In no case, even when the accidental contact above assumed occurs, should the voltage produced in line L_1 exceed 250 volts.

(*d*) All connections to earth, made on the coupling devices, should be carried out in accordance with the usual rules covering the earthing of high tension installations, imposed by each country.

(*e*) Regarding operating practice, the owner of the private lines should be responsible for the regular conditioning of the whole installation and for its maintenance in conformity with the rules outlined above.

II. Conditions to be Fulfilled in Cases where a Telephone Line, L_1, Carried on the Poles or in the Cables of a Public Telephone Network, is Connected to a Telephone Line, L_3, Operated as a Carrier Circuit, Superimposed on the High Tension Line.

(*a*) The coupling devices between the two telephone lines L_1 and L_3 should conform to the best practices of the art.

(*b*) In all cases, even when a breakdown occurs in the coupling device between the high tension line and the carrier circuit, the possibility of high tension reaching line L_1 should be rigorously guarded against.

(*c*) In no case, even when a breakdown as above assumed takes place, should the voltage produced in line L_1 exceed 250 volts.

Bearing in mind the high voltages used in carrier telephony (for example, the plate voltage) an insulating transformer should be inserted between the carrier installation and line L_1, which transformer should be capable of withstanding without damage a potential of at least three times the maximum voltage which may occur under normal operating conditions in a carrier telephone installation.

(*d*) All connections to earth, made on the coupling devices, should be carried out in accordance with the usual rules covering the earthing of high tension installations imposed by each country.

(*e*) Regarding operating practice, the owner of the private lines should be responsible for the regular conditioning of the whole installation and for its maintenance in conformity with the rules outlined above.

Recommendation No. 17.

Principles of Protection.

The International Telephone Consultative Committee—

Considering :—

That there exist at the present time great differences in the protective systems used and that it would be of interest to unify these systems, making them simple, efficient and economical,

Unanimously advises :—

1. That the principle of protection should be first of all to choose judiciously the constructional characteristics of lines and installations and their conditions of installation and that, in general, a supplementary role should be assigned to the protective devices.

2. That, in general, any telephone circuit (interurban circuit or subscriber's loop) entirely in underground cable and not having any direct earth connection and not being connected to any earthed installation, should not be provided with any protective device ;

That, under these conditions, if the circuit is exposed to induction from power lines, the total longitudinal induction should not exceed 60 per cent. of the breakdown voltage of any part of the cable circuit ;

That if the induction exceeds this limit for a certain part of the circuit, for example, the transformers, it is desirable to replace those parts of the circuit which do not comply with the above condition or to reduce the value of the induction.

Recommendation No. 18.

Ideal Protective Device.

The International Telephone Consultative Committee—

Considering :—

That the protective devices actually used have been developed, some to protect against atmospheric discharges and others to protect against risk of contact with or induction from high tension lines.

Unanimously advises :—

That an ideal protective device should fulfil both of the two above noted requirements ;

That such a device can apparently be constituted in the following way :—

1. A simple arrestor (saw tooth or knife edge . . .) of which the breakdown voltage is about 2 000 volts.

2. A fuse where the wire fuses in less than n seconds when it carries a current between 0.5 and 1 A ;—which does not give rise to an arc if a source of supply of 750 V (E.M.F.) and adequate power is connected to its terminals,—and which can withstand ten successive discharges of 8 joules, spaced at intervals of 10 seconds.

3. A rarefied gas arrestor whose breakdown voltage is about 300 volts and which can withstand without damage both the prolonged flow of a current insufficient to cause the fuse to operate and the flow of a current greater than that which will cause the operation of the fuse in the required time ;

Note.—Administrations and Operating Companies who are already using a protective device which satisfies the above conditions are asked to send the specification, description, and results of tests, to the Secretariat of the C.C.I.F. in order to complete the information available on this subject.

Other Administrations and Operating Companies are requested to submit the above requirements to their suppliers and to ask them to study its manufacture.

Recommendation No. 19.

Principal Characteristics of Protective Devices.

The International Telephone Consultative Committee—

Considering :—

That the chief characteristics of the various protective devices used in different countries, as already reported by Administrations and Operating Companies and tabulated hereinafter, do not appear to be based on the same principles of measurement and designation ;

That, on the other hand, precise and well-defined data should be available for a comparison between the various forms of the same protective device.

Unanimously recommends :—

That the chief characteristics of the protective devices used in various countries and tabulated in the following Appendix should be verified with due regard to the recommendations made in Note I, entitled : " Principal characteristics of protective devices."

Note.—In accordance with the information contained in Note I Administration and Operating Company members of the C.C.I.F. have supplied the information contained in Note II below entitled " Tabular representation of protective devices used on telephone installations in various countries to protect personnel and installations against possible damage from power lines or from atmospheric discharges."

NOTE I.

PRINCIPAL CHARACTERISTICS OF PROTECTIVE DEVICES.

This note enumerates the constructional and functional characteristics of protective devices which should be considered when a comparison is to be made between different types. Where it has appeared useful the principle of a measuring method for determining the characteristics has been indicated. For certain characteristics an exact definition has been added.

In this note merely a study of protective devices has been contemplated. In fact, the determinations indicated should be applied to several specimens of the same type and should be compared among themselves. When it is necessary to ascertain if samples conform with a standard, simplified methods may obviously be used.

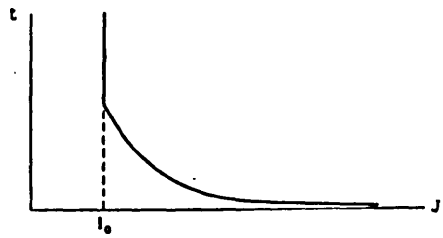
I. FUSES.

(*a*) **Description.**—Material and dimensions of the fuse wire ; form and, when possible, method of replacing the fuse wire ; if possible, operating details, etc.

(*b*) **External form.**—Method of mounting and admission of current, accessibility. . . .

(*c*) **Resistance.**

(*d*) **Operating value.**—It is possible to plot a characteristic curve representing as a function of the current J flowing through the fuse (direct or alternating current), the time t required to blow the fuse. That curve is asymptotic on the one hand to the line $t = o$ and on the other hand to a line parallel



to the time axis. If I_0 is the abscissa of that line, its value may be adopted as the operating current of the fuse. (*See* curve.)

(*e*) **Calorific capacity.**—The calorific capacity of a fuse is the maximum energy which can be almost instanteously absorbed by the fuse without blowing it. In practice it is sufficient to determine this value to within $\pm$ 10 per cent. To ascertain the calorific capacity, repeated discharges from a bank of condensers are sent through the fuse. If C is the capacity of this bank of condensers and V the voltage to which they are charged, then the energy absorbed by the fuse is $\frac{1}{2} CV^2$, provided the losses in other parts of the discharging circuit are negligible. The latter should be wired up with heavy conductors and all contacts should be good.

One can ascertain whether or no the losses in the discharging circuit are negligible, either by

varying the capacity and the voltage or else by testing several fuses simultaneously. It is immaterial to the calorific capacity of a fuse, whether fuses are wired in series or parallel.

Since, during a thunderstorm, several atmospheric discharges may follow each other in almost immediate succession and that, therefore, heat may be stored up in the fuse, it is desirable to test with at least ten discharges, at intervals of ten seconds.

(*f*) **Voltage under which the current can be interrupted.**—When a fuse is connected to a source of direct current (or to a supply network) of high voltage and great power, it may be fear ed that the fusing of the wire may be followed by an arc. In order to ensure that an arc is not maintained in the cartridge of the fuse the following method may be used : in series with the fuse either a circuit breaker or else another fuse is connected which is capable of operating until a longer period has elapsed than is required for the fuse under test to blow. Thus the operation of the circuit breaker or the larger fuse indicates the maintenance of an arc in the smaller fuse. In general, this test requires means which are not ordinarily at hand in telephone laboratories.

II. HEAT COILS.

All the characteristics listed under the title of fuses, with the possible exception of calorific capacity, should be considered in connection with heat coils or any other device used for the same purpose.

At any rate it is of great interest accurately to define the characteristic curve under (*d*) and the voltage referred to in (*f*) above.

It should also be noted whether or not the heat coil is of the regenerative type, either automatic or hand-operated. It should therefore be ascertained how many times a heat coil may be used.

III. LIGHTNING ARRESTORS.

(*a*) **Description.**—Nature, shape and arrangement of the electrodes and their external connection. Nature and atmospheric pressure surrounding the electrodes.

(*b*) **External construction.**—Method of mounting and entry of current, accessibility. . . .

(*c*) **Insulation.**

(*d*) **Operating voltage.**—If a continuous voltage is applied to the terminals of a lightning arrestor, and is then gradually raised, a value will be found above which the arrestor will operate ; this is indicated by the flow of a current, which can be measured on an instrument.

The voltage thus defined may be called the operating voltage of the arrestor. Certain types of arrestor lend themselves to an interpretation of their function through the plotting of a characteristic curve, showing the relation between the continuous voltage at the terminals of the arrestor and the amount of current passing through it. In general, this curve presents several parts corresponding particularly to the functioning of the discharge and that of the arc. It is useful to determine (within perhaps $\pm$ 20 per cent.) the values of the current density, at which changes occur.

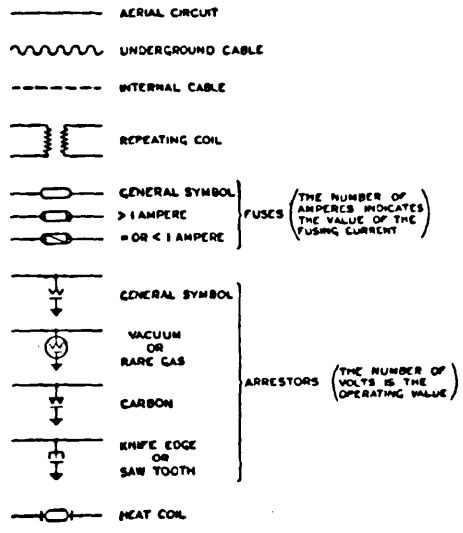
Heating-up of the arrestor should be avoided when obtaining the characteristic. Also, in case of high values, the time allowed for the current to flow should be reduced and the intervals between operations prolonged.

Incidentally, it will be of interest to observe how the voltage varies at the terminals of the arrestor when the testing current is applied for an appreciable length of time. Similarly, it will be of interest to observe how the operating voltage varies at the end of more or less prolonged operations of the protector.

An arrestor may be dissymmetrical, depending on the direction of the voltage applied ; in that case the characteristic just defined will not be the same if the voltage is reversed. This point should be investigated.

The following tables show the protection devices in use in the various countries.

CONVENTIONS.



1 INTERURBAN CIRCUIT IN UNDERGROUND CABLE.

ADMINISTRATION	EXCHANGE	LINE
GERMAN		CABLE, LOADING COILS, REPEATING COILS, TESTED WITH 1000 V RMS TO EARTH AT 50 p.s.
A.T. & T. Co		
AUSTRIAN		
BELGIAN		
BRITISH	(a) 0·5A, 15-60 SEC. (b) 0·5A, 2·0 SEC. ORDINARY (a) 300-500 V. (b) 500-600 V. 3A	
	(a) 0·5A, 15-60 SEC. (b) 0·5A, 2·0 SEC. WITH REPEATING COIL (a) 300-500 V (b) 500-600 V. 3A	
	ASSOCIATED WITH A REPEATER	
FRENCH		
HUNGARIAN	0·5A 3 MIN. GRADUALLY SUPPRESSED	
JAPANESE		
NORWEGIAN	0·5A 45 Ω 425 V.	
DUTCH	0·25A 45 Ω	
SWEDISH	3A 700-1000 V. 3A	
CZECHO-SLOVAKIAN		
USSR		

2. OPEN WIRE INTERURBAN CIRCUIT.

ADMINISTRATION	EXCHANGE A.	LINE	EXCHANGE B
GERMAN	0·5A 45 Ω 350 V. 5A APPROX 2000 V.		SAME AS EXCHANGE A
A.T. & T. Co.	0·5 mm WIRE 350 V.		SAME AS EXCHANGE A
AUSTRIAN			SAME AS EXCHANGE A.
BELGIAN	0·5A 0·5A 30 Ω 3A > 220 V IN SPECIAL CASES VACUUM TYPE 350 V.		SAME AS EXCHANGE A
BRITISH	(a) 0·5A 15-60 SEC. (b) 0·5A. 2·0 SEC. 3A (a) 300-500 V (b) 500-600 V		SAME AS EXCHANGE A.
FRENCH	1A 3A NON MULTIPLE SWITCHBOARD 500 V.		3A 0·5A 30 Ω 500 V MULTIPLE SWITCHBOARD
HUNGARIAN	0·5A 3 MIN 5A 450 V. (750 V.)		SAME AS EXCHANGE A
JAPANESE	0·5A 2·0 Ω 2A OR 4A AS REQ'D 300 Ω 600 V.		SAME AS EXCHANGE A
NORWEGIAN	0·5A 45 Ω 3A 425 V		SAME AS EXCHANGE A
DUTCH	0·25A 45 Ω NEON TYPE 150-170 V		SAME AS EXCHANGE A
SWEDISH	3A 3A 700-1000 V		SAME AS EXCHANGE A
CZECHO-SLOVAKIAN			SAME AS EXCHANGE A
USSR	(a) ORDINARY CASE 0·25A 0·25A 87-1A 350-500 V		SAME AS EXCHANGE A

EXCHANGE	LINE	TEST BOINY ON LINE	LINE
(b) AERIAL CIRCUIT IN THE NEIGHBOURHOOD OF HIGH TENSION LINE (WHEN THE EMF INDUCED BY SHORT CIRCUIT CURRENT IS GREATER THAN 750 V.) 0·25A 87-1A 450-600 V. 270-330 V 30A THE VOLTAGE TO EARTH ON ANY PART OF THE TELEPHONE LINE SHOULD NOT EXCEED 375 V		270 330 V 30A	

Note.—When alternating current is used a rapid determination of the operating voltage may be made and the dissymmetry feature of the arrestor verified by means of an oscillograph, which shows the behaviour of the current and its wave form. For this investigation it is necessary to use a source of voltage free from harmonics.

(*e*) **Ruggedness.**—It is necessary to determine the life of the arrestor, during which it will not deteriorate, nor show important changes in the operating voltage after cooling, when passing currents of various strengths, increasing in value, step by step, from 0.1A up to the point where the fuse associated with the arrestor blows.

Since in practice a current greater than I_0 is interrupted in a given time (as shown by the characteristic curve), it is necessary to ascertain that the arrestor will stand a large number of charges during the time required for the associated fuse to blow.

This test may be made with direct or alternating current, as required.

---

3. INTERURBAN CIRCUIT NOT ENTIRELY IN CABLE.

ADMINISTRATION	EXCHANGE A.	LINE	EXCHANGE B
GERMAN	0.5A 8A 45 S. APPROX 2000 V. EXCEPT IN THE CASE WHERE THE CABLE IS ENTIRELY UNDERGROUND	APPROX 2000 V. 350 V.	8A 0.5A 45 S. APPROX 2000 V. 350 V.
A.T.&T.Co (SEE NOTE A)	CARBON ARRESTOR (350 V)	OPEN WIRE LINE. SHEATH OF UNDERGROUND CABLE. C. SHEATH OF AERIAL CABLE. JUNCTION POINT OF UNDERGROUND AND AERIAL CABLE.	F. CARBON ARRESTOR (350 V)
	F. FUSE (7A CONTINUOUS, 10 5A FOR 5 MIN) C. CARBON ARRESTOR (710 V) PLACED BETWEEN THE OPEN WIRE LINE AND THE SHEATH OF THE AERIAL CABLE (PRESENT PRACTICE CONSISTS IN CONNECTING THE ARRESTOR TO THE CABLE SHEATH RATHER THAN TO EARTH AT THE JUNCTION OF CABLE AND OPEN WIRE LINE).		
AUSTRIAN			
BELGIAN	NO SPECIAL INDICATIONS.	> 220V. IN SPECIAL CASES VACUUM TYPE (320 V.)	NO SPECIAL INDICATIONS.
BRITISH	(a) 0.5A, 15-60 SEC. (b) 0.5A, 210 SEC. 3A. (a) 300-500V. (b) 500-800V. AS ABOVE	IN CASES WHERE THE CABLE IS SUBMARINE OR UNDER RIVER AND IN CASES WHERE THE UNDERGROUND CABLE CONTAINS IMPORTANT CIRCUITS AND WHERE THE COST OF THE PROTECTIVE APPARATUS DOES NOT EXCEED HALF THE COST OF THE UNDERGROUND CABLE. 3A. IN OTHER CASES.	(a) 0.5A, 15-60 SEC. (b) 0.5A, 210 SEC. 3A. (a) 300-500V. (b) 500-800V. AS ABOVE
FRENCH	3A. 400 V.	10A. 400 V.	3A. 0.5A. 500 V. 30 S.
HUNGARIAN	NO SPECIAL INDICATIONS.	450 V. (750 V.) 5A.	NO SPECIAL INDICATIONS.

3. (CONTINUED) INTERURBAN CIRCUIT NOT ENTIRELY IN CABLE.

ADMINISTRATION	EXCHANGE A	LINE	EXCHANGE B
JAPANESE	CASE 1. (SEE NOTE 1) 0.5A 2A. 210 S. 240 P.S. 270 V. IN THE CASE WHERE THE LEADING-IN CABLE IS AT LEAST 100 METRES.	UNDERGROUND OR AERIAL CABLE. 2A. 240 P.S. 270 V.	2A. 0.5A. 240 P.S. 270 V. 210 S.
	CASE 2. (SEE NOTE 2) 0.5A. 4A. 210 S. 300 P.S. 500 V. IN THE CASE WHERE THE LEADING-IN CABLE IS AT LEAST 100 METRES.	UNDERGROUND OR AERIAL CABLE. 5A. 300 P.S. 500 V.	4A. 0.5A. 300 P.S. 500 V. 210 S.
	CASE 3 (SEE NOTE 3) 0.5A. 2A. 210 S. 240 P.S. 270 V. IN THE CASE WHERE THE LEADING-IN CABLE IS AERIAL.	UNDERGROUND OR AERIAL CABLE. 2A. 240 P.S. 270 V.	2A. 0.5A. 240 P.S. 270 V. 210 S.
	CASE 4. (SEE NOTE 4) 0.5A. 2A. 210 S. 300 P.S. 500 V. IN THE CASE WHERE THE LEADING-IN CABLE IS AERIAL.	UNDERGROUND OR AERIAL CABLE. 2A. 300 P.S. 500 V.	2A. 0.5A. 300 P.S. 500 V. 210 S.
	NOTES: 1. OPEN WIRE LINE WITH NON-LOADED LEADING-IN CABLE AND EXPOSED TO DANGEROUS HIGH TENSION. 2. OPEN WIRE LINE WITH NON-LOADED LEADING-IN CABLE AND NOT EXPOSED TO DANGEROUS HIGH TENSION. 3. OPEN WIRE LINE WITH LOADED LEADING-IN CABLE AND EXPOSED TO DANGEROUS HIGH TENSION. 4. OPEN WIRE LINE WITH LOADED LEADING-IN CABLE AND NOT EXPOSED TO DANGEROUS HIGH TENSION.		
NORWEGIAN	NO SPECIAL INDICATIONS	NO INDICATIONS	
DUTCH	0.25A. 15 S.	150-170 V. NEON TYPE	NO SPECIAL INDICATIONS
SWEDISH	1ST CASE. NO SPECIAL INDICATIONS	SHORT CABLE INSERTED ON A LONG AERIAL SECTION OR SHORT AERIAL SECTION INSERTED ON A LONG CABLE. 3A. 350 V.	NO SPECIAL INDICATIONS
	2ND CASE. NO SPECIAL INDICATIONS	LONG CABLE CIRCUIT INSERTED ON A LONG OPEN-WIRE LINE	NO SPECIAL INDICATIONS
USSR	0.25A	8J-1A. 350-500 V.	8J-1A. 0.25A. 350-500 V.

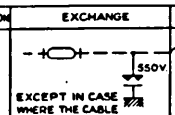
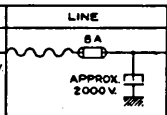
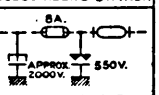
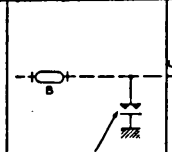
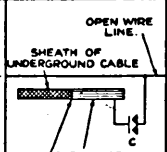
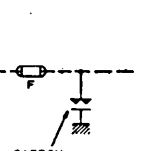
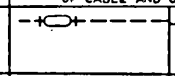
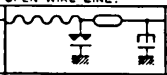
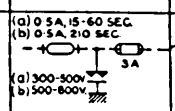
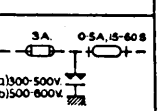
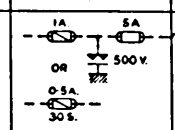
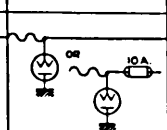
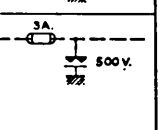
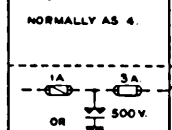
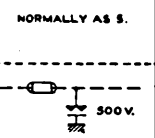
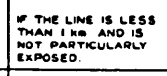
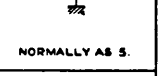
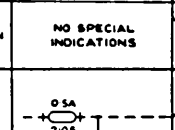
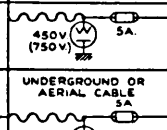
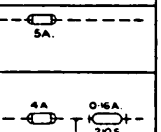
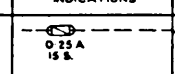
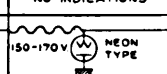
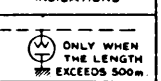
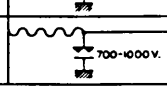
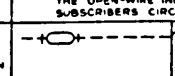
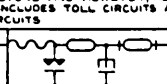
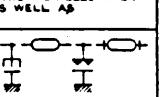
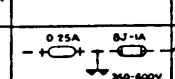
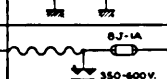
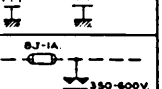
4. SUBSCRIBERS LINE IN UNDERGROUND CABLE.

ADMINISTRATION	EXCHANGE	LINE	SUBSCRIBER'S STATION
GERMAN.			
A.T.&T. Co	0·5A, 21Ω S, 350V. (IF ALL SUBSCRIBERS' LINES CONNECTED TO AN EXCHANGE ARE UNDERGROUND OR ONLY HAVE SHORT SECTIONS OF AERIAL LINE NOT EXPOSED TO HIGH TENSION LINES OVER 250v. THE CARBON ARRESTORS CAN BE OMITTED		
AUSTRIAN			
BELGIUM			
BRITISH	EXCHANGE WITH LESS THAN 12 CIRCUITS AND WITHOUT EARTH CONNECTIONS		WHERE THERE ARE LESS THAN 12 SUBSCRIBERS SETS AND NO EARTH CONNECTIONS
	EXCHANGE WITH LESS THAN 12 CIRCUITS BUT WITH EARTH CONNECTIONS. (a) 0·5A, 15-60 SEC (b) 0·5A, 240 SEC. 3A		WHERE THERE ARE LESS THAN 12 SUBSCRIBERS SETS AND NO EARTH CONNECTIONS.
			WHERE THERE ARE LESS THAN 12 SUBSCRIBERS SETS BUT WITH EARTH CONNECTIONS. 3A, 0·5A, 15-60 SEC.
	EXCHANGE WITH MORE THAN 12 CIRCUITS (a) 0·5A 15-60 SEC (b) 0·5A 240 SEC. 3A (a) 300-500 v (b) 500-800 v		WHERE THERE ARE LESS THAN 12 SUBSCRIBERS SETS AND NO EARTH CONNECTIONS.
			WHERE THERE ARE LESS THAN 12 SUBSCRIBERS SETS BUT WITH EARTH CONNECTIONS. 3A, 0·5A, 15-60 SEC.
			WHERE THERE ARE MORE THAN 12 SUBSCRIBERS SETS. 3A, USA, 15-60 SEC. (a) 300-500 V (b) 500-800 V
FRENCH	0·8A, 30Ω	3A	
HUNGARIAN	0·8A, 3 MIN.		NO INDICATIONS
JAPANESE			
NORWEGIAN	3A, 425 V.		NO INDICATIONS
DUTCH	0·25A, 15Ω		
SWEDISH	0·25A, 20Ω, 3A, 700-1000 V.		NO INDICATIONS.
CZECHO-SLOVAKIAN			
U.S.S.R.	0·25A, 0·25A		

5 SUBSCRIBER'S OPEN WIRE LINE

ADMINISTRATION	EXCHANGE	LINE	SUBSCRIBER'S STATION
GERMAN	0·5A, 8A, 45Ω, 550V, APPROX 2000V		8A, 0·5A, APPROX 2000V, 45Ω, 550V
A.T.&T.Co	0·5A, 7A, 21Ω, 350V, 0·5mm WIRE		7A, 350V
AUSTRIAN			
BELGIAN	0·5A, 3A, LOCAL BATTERY, >220V, 0·5A 30Ω, COMMON BATTERY		3A, >220V, IN SPECIAL CASES VOLTAGE TYPE 320 V
BRITISH	(a) 0·5A 15-60 SEC (b) 0·5A, 240 SEC 3A. (a) 300-500V (b) 500-800V		3A, 0·5A 15-60S, (a) 300-500V (b) 500-800V
FRENCH	NON MULTIPLE 3A, 1A OR, 500V, 0·5A, 30S, MULTIPLE SWITCHBOARD		3A, 500V
HUNGARIAN	0·5A, 5A, 3 MIN, 450V (750V)		(a) 5A, 0·2A, OR, (b) 0·2A, 0·2A.
JAPANESE	0·5A, 4A, 21Ω S, 300p.s 500V		4A, 0·15A, 21Ω S, 300p.s 500V
NORWEGIAN	3A, 425V.		NO INDICATIONS
DUTCH	0·25A, 15Ω, NEON TYPE 150-170V.		IF LENGTH OF SUBS LINE IS GREATER THAN 500m NEON TYPE 150-170V
SWEDISH	0·25A, 3A, 20Ω, 700-1000V.		3A, 700-1000V, IF LINE IS CROSSED BY HIGH TENSION LINES
CZECHO-SLOVAKIAN			
U.S.S.R.	0·25A, 0·25A, BJ-1A, 350-500V		BJ-1A, 350-500V

6. SUBSCRIBER'S LINE NOT ENTIRELY IN CABLE.

ADMINISTRATION	EXCHANGE	LINE	SUBSCRIBER'S STATION
GERMAN	 EXCEPT IN CASE WHERE THE CABLE IS ENTIRELY UNDERGROUND.		 NORMALLY AS 5.
A.T. & T Co. (SEE NOTE B)			
	F. FUSE (7A CONTINUOUS, 10·5 A FOR 5 MIN) B. HEAT COIL (0·35A CONTINUOUS, 0·54A FOR 210 SEC.) C. CARBON ARRESTOR (710 V.) PLACED BETWEEN THE OPEN WIRE LINE AND THE SHEATH OF THE AERIAL CABLE. (PRESENT PRACTICE CONSISTS IN CONNECTING THE ARRESTOR TO THE CABLE SHEATH RATHER THAN TO EARTH AT THE JUNCTION OF CABLE AND OPEN WIRE LINE.		
AUSTRIAN			
BELGIAN	NO SPECIAL INDICATIONS		NO SPECIAL INDICATIONS
BRITISH			
FRENCH	 NORMALLY AS 4.	 IF THE LINE IS MORE THAN 1 km OR IS PARTICULARLY SUBJECT TO LIGHTNING.	 NORMALLY AS 5.
	 NORMALLY AS 4.	IF THE LINE IS LESS THAN 1 km AND IS NOT PARTICULARLY EXPOSED.	 NORMALLY AS 5.
HUNGARIAN	NO SPECIAL INDICATIONS		
JAPANESE	 IF CROSSED BY POWER LINES.		
	NOTE - IN THE CASE OF AN AERIAL OR UNDERGROUND CABLE CONNECTED TO AN OPEN-WIRE LINE THE PROTECTIVE DEVICE SHOULD NOT BE INSTALLED AT THE TERMINALS OF THE CABLE		
NORWEGIAN	NO SPECIAL INDICATIONS	NO INDICATIONS	NO SPECIAL INDICATIONS
DUTCH			
SWEDISH	NO SPECIAL INDICATIONS		NO SPECIAL INDICATIONS
	NOTE - IN MOST CASES CARBON LIGHTNING ARRESTORS ARE NOT USED BETWEEN OPEN-WIRE CIRCUITS AND CIRCUITS IN CABLE IF THE OPEN-WIRE ONLY CONTAINS SUBSCRIBERS CIRCUITS. LIGHTNING ARRESTORS ARE, HOWEVER, ALWAYS INSTALLED WHEN THE OPEN-WIRE INCLUDES TOLL CIRCUITS AS WELL AS SUBSCRIBERS CIRCUITS		
CZECHO-SLOVAKIAN			
U.S.S.R.			

NOTE A

(See diagram 3. Interurban circuit not entirely in cable.)

Protection of Exchange.

(*a*) Six to thirty metres of No. 24 ga. protection cable (with 0.51 mm diameter wires placed at the junction points of aerial with underground cable, or in the exchange when the cable entering the exchange is aerial.

(*b*) No fuses are used when the cable contains only interurban circuits and when the underground section between the aerial section and the exchange exceeds the lengths specified below for the given conditions :—

2 miles when the biggest conductor of the underground section is No. 19 ga.
4 „ „ „ „ „ „ „ „ „ „ No. 16 „
8 „ „ „ „ „ „ „ „ „ „ No. 13 „

(*c*) When any of the above conditions are not fulfilled as, for example, in the case of entrance cables of small exchanges, 7-A fuses should be used at the exchange.

NOTE B

(See diagram 6. Subscriber's line not entirely in cable.)

Protection of Exchange.

Protection is ensured by means of a cable of 0.5 mm diameter wires at the junction of aerial and underground cable or in the exchange when the cable entering the exchange is aerial. If any of these conditions are not fulfilled as for example in the case of entrance cable to small exchanges, 7-A fuses should be used at the exchange.

PART II.

PROTECTION OF TELEPHONE CABLES AGAINST CORROSION DUE TO ELECTROLYSIS

I.—Advice of the International Telephone Consultative Committee.

Recommendation No. 1.

Information on the effects of Electrolysis and Collaboration with Interested Organisations.

The International Telephone Consultative Committee—

Considering :—

That research on faults on underground cables and the repair of these faults may involve considerable cost ; that the interruptions in the service which may result from the presence of these faults should be avoided with great care ; that even if the repair has been carried out as well as possible, the quality of the cable may be decreased and its normal life reduced,

Unanimously recommends :—

That it is desirable in the interests of long-distance telephony to publish certain information capable of assisting the different Administrations and Operating Companies in overcoming the effects of electrolysis due to return currents from electric traction.

That certain appropriate measures taken during installation or during the maintenance of telephone cables can reduce the gravity of the effects of electrolysis, and that the most effective means of preventing damage certainly consists in decreasing the severity of their cause, that is in preventing the establishment of excessive potential difference between the return conductors of traction systems and the cable sheath.

That this can be done by observing certain technical rules during the installation of traction lines by making a suitable arrangement of both feeders and network for the return current when the traction system is in operation, and by arranging for a very strict maintenance.

That nevertheless in order to describe these various precautions with sufficient accuracy, the general conditions of operation of the traction system must be taken into account.

That in the case of railways forming part of the general network present knowledge on the question does not yet permit of rules being made which would be applicable to these lines, but that the present development of electric traction warrants a continuation of the studies undertaken in this respect.

That, on the other hand, the adoption of suitable precautions to be taken in each particular case for the maintenance of telephone cables often takes for granted a sufficient knowledge of the operating conditions of near-by railways, and that the interests of Telephone Administrations and Operating Companies are similar in this respect to those of other Administrations.

Unanimously recommends :—

That it is advisable that the study of protective measures against stray currents should continue to be carried out by the C.C.I.F. in collaboration with the international organisations representative of the various interests concerned such as the International Union of Tramways, local railways and public automobile transport, the International Gas Union, the International Railway Union, the International Union of Producers and Distributors of Electric Power, and the C.I.G.R.E.

That it is advisable that all Administrations and Operating Companies while applying to their own underground network measures enhancing their security against electrolytic damage, should collaborate with the other interested Administrations (water, gas, electricity . . .) to establish in common, in each particular case, the best conditions of installation, maintenance and inspection of their networks and to agree as to any helpful arrangements.

Recommendation No. 2.

Committee for the Revision of Recommendations concerning Measures for the Protection of Cables against Electrolytic Corrosion.

The International Telephone Consultative Committee—

Considering :—

That studies carried out since 1931 and especially those whose results were recorded at the IIIrd and IVth Plenary Meetings of the C.M.I. permit of important modifications being made to the Recommendations concerning measures to be taken for the protection of cables against electrolytic corrosion, established by the C.C.I.F. in 1931.

That the Xth Plenary Meeting has already studied the revision of this, so far as concerns the parts relative to drainage and the use of insulating joints, also the calculation of rail voltages to earth.

That the principle involved in further modifications arising from results obtained by the C.M.I. may also be approved.

Unanimously recommends :—

(1) That a complete revision of the Recommendations made in 1931 should be undertaken, on the basis of the principles contained in the following annex.

(2) That for the purpose of this revision the C.C.I.F. should obtain the collaboration of the organisations representing the electrical industry and of those organisations interested who are members of the C.M.I. (Union Internationale des Chemins de fer, C.I.G.R.E., Union Internationale de Tramways, chemins de fer d'interet local et transport publics automobiles, Union Internationale de l'Industrie du Gaz).

(3) That the work should be so organized that a new edition can be presented at the next Plenary Meeting; that accordingly it is necessary to entrust the work to a very limited committee working under the chairmanship of the Chief Rapporteur of the 2nd C.R. and consisting of one representative from the Telephone Administrations of Germany, Belgium, France, Great Britain and Italy, together with one representative from each of the international organisations detailed in paragraph (2) above.

Note.—The history of this question is briefly given below.

A first issue of Provisional Recommendations for measures to be taken for the protection of cables against electrolytic corrosion published by the C.C.I.F. in 1927 (and reprinted in the Yellow Book of the C.C.I.F. in 1930) was for more than three years under examination by telephone authorities as well as by the Union Internationale des Tramways, Chemins de fer d'interet local and Transports publics automobiles (U.I.T.) ;

This formed the subject of careful study by the Union Internationale des Tramways, a study which has produced detailed comments by very competent people as regards matters of electrolysis.

Except for a few minor points, the main differences between the sets of regulations drawn up by the C.C.I.F. and the U.I.T. respectively consisted in the fact that the U.I.T. fixed a maximum of 2.5 volts for the potential difference between any two points on the network, whereas the C.C.I.F. fixed a value of 0.8 for the voltage limit between rails and earth in the corrosion zones.

To check that neither one or other of these limits was exceeded a preliminary calculation was made in each case of the current distribution in the rails and return feeders supposing the system perfectly insulated from earth, a calculation which was obviously identical in each case whatever conclusions might be drawn from it.

The difference between the two sets of regulations arose in that, after this preliminary calculation, the C.C.I.F. considered the effect of the resistance between rail and earth in order to fix the points of

zero potential in the network, assuming that the current taking this route does not actually affect the current and voltage distribution in the rails and return feeders obtained by the calculation.

In this C.C.I.F. calculation average values were used for resistance between rails and earth which agreed with those found by the Bureau of Standards (U.S.A.) after a long series of tests, and also with those shown by the U.I.T. study.

Accordingly it was considered that the C.C.I.F. regulations being based on a calculation taking into account the two factors, resistance of rails and resistance from rail to earth, was satisfactory from the technical point of view.

However, after the study of this question which took place in 1931, the C.C.I.F. thought fit to modify their first set of regulations to take into account certain remarks by the U.I.T. and especially to specify that the rule of 0.8 maximum negative voltage should not apply to sections where the average resistance between rail and earth was high.

The study of this question has been continued since 1931 and the situation is now as follows :—

The instructions contained in the Plan of Recommendations for protection of cables against electrolytic corrosion (see Part 2 B below) which reproduces the previous text modified by taking into account Recommendation No. 4, may be considered as provisionally valid, except for modifications arising out of Recommendation No. 3 and those mentioned in the note below.

NOTE

Main modifications to be made to the "Recommendations for protection of cables against electrolytic corrosion."

1. Protective measures should not be confined to a few steps taken in the area where corrosion has occurred. An overall view embracing the whole network of the cable and, if necessary, networks of other underground conduits should be taken. To avoid electrolytic corrosion it is necessary to prevent or to restrict as far as possible the flow of stray current between the cable sheath and its surroundings.
2. General measures of prevention should be re-examined which must be taken in all cases of cables situated in the stray current field, whatever the origin of these currents may be.
3. It is necessary to revise more correctly and exactly the Recommendations concerning electric traction networks (for instance, by avoiding the vague idea of voltage to earth, by defining what is called the conductance coefficient, real and mutual conductance of insulation, etc.).
4. It is necessary to remark on the good results obtained by combining electric drainage with insulating joints as well as by using non-reversible (polarised) drainage devices.
5. Cathodic protection should be mentioned.
6. The note relative to the calculation of voltage throughout a network should be revised.
7. A revision should be made of the Annex containing testing methods which should take into account the results obtained by the C.M.I. in 1932 and 1936.
8. A brief account will be given of the principle of the method of plotting stray currents by means of the differential device designed by M. Schlumberger and improved by M. Gibrat.
9. The principles of the methods of determining the values of the conductance coefficient will be described as well as the various resistances and conductances which should be considered.
10. The text of certain passages which especially concern measures to be taken on telephone cable networks (Chapter C of the 1931 proposition paragraphs 6, 7, 8 and 9) will be modified, as follows:—

    C.6. Each individual case of plain lead-covered cables meeting in pulling-in boxes, jointing boxes, or in distribution boxes, should be separately studied to ascertain whether their

sheaths should be interconnected by metallic conductors soldered to the sheath or whether on the other hand they should be left insulated from one another. In the case of metal conduits containing telephone cables, electrical interconnection should also be carried out.

C.7. The application of an insulating sheath, more or less perfect, to the sheaths of those cables only which are the more exposed to corrosion does not provide a complete protection against corrosion which may then occur outside the protected cable area, or at bare spots, if any, in the insulating cover, where it has sometimes been noticed that an increased corrosion takes place.

A simple coating of insulating paint or a thin insulating covering applied to the whole cable system or throughout extensive areas, especially at those points where the current has a tendency to enter the cable, may give some protection.

C.8. On the other hand when the insulating sheath covering the cable is applied to a sufficiently long length, is sufficiently thick, and is protected mechanically and chemically, either by the cable protection (as in armoured cables) or by the conditions under which the cable is installed (cable in conduit) or itself is sufficiently watertight and durable, the protection against electrolytic corrosion afforded may be considered as sufficiently good in many cases.

A similar method of protection can be obtained by covering the cable with an insulating compound during placing.

The use of these methods of protection is especially to be recommended in the following cases : crossing of the cable route with that of electric traction lines, passage over metallic bridges, proximity to conducting structures more or less directly in contact with the traction rails, or sudden change in distance between cable and traction line. In any case, the length of cable thus protected should be sufficiently long.

C.9. Complementary methods of protecting cable networks against corrosion consist in the use of insulating joints, in drainage and in the use of earth plates. Information as to the method of use of these will be given later.

C.10. A further step for protection of cables can be taken by the use, at the points where the current leaves the cables, of various semi-conducting or colloidal coatings which while not preventing the current leaving, hinder electrolytic corrosion.

Recommendation No. 3.

Calculation of rail voltage with regard to earth and the limitation of this voltage.

The International Telephone Consultative Committee—

Considering :—

That in the Proposed Recommendations for the protection of cables against electrolytic corrosion drawn up by the C.C.I.F. in 1931 the following paragraph appears : " In the area served by an urban tramway where stray current flows from pipes or cable sheaths the calculated average voltage between rail and earth should not exceed 0.8 volt in sections where the rail has a low resistance to earth (for instance in the case of buried rails)."

That this rule has always been the subject of the liveliest criticism from the Union Internationale des Tramways.

That important studies, both experimental and theoretical, have been made on this subject and the results reported to the C.M.I. have been the subject of earnest discussion.

That such discussions have shown that even if this rule has not a flawless theoretical basis, it still has considerable practical interest. Since on the one hand, countries where such a regulation is in force have stated that its observation has been conducive to a considerable reduction in the severity

of electrolytic corrosion due to stray traction current and on the other hand it appears from a theoretical discussion that the bases of the calculation which led to the adoption of this regulation are in many cases sufficiently exact.

That in order to be able to make this calculation and to correctly understand it, values for conductance coefficients may, under certain circumstances be selected depending upon the nature of the rails and their installation, " coefficients " of which the exact determination appears to be difficult and the approximation of which can only be left to engineers who in a long experience of similar studies have gained experience in the various combinations of circumstances to be met with in such work.

That in place of the regulation mentioned above some countries make use of a more simple regulation which is possibly less satisfactory from a theoretical point of view but which long experience has shown is conducive to a satisfactory reduction of risk of electrolytic corrosion ; that the application of this regulation appears to raise fewer objections on the part of the Union Internationale des Tramways, than in the case of the regulation previously mentioned.

Unanimously recommends :—

That the paragraphs relative to this subject in the Plan of Recommendations should be modified and re-issued on the following lines :—

1. The rule for the limitation of the mean voltage of the rails with regard to earth, should no longer be given as a rule for universal application, but as one which, in those countries where it has been established by agreement between the Tramway Authorities and other Authorities having underground networks of cable, pipes, etc., has led to the almost complete suppression of electrolytic corrosion. It should also be mentioned that the calculation of the mean voltage of the rails with regard to earth should be compared with tests made of the mean voltage of the rails with respect to other underground conduits, etc., in proximity to them, and that a serious discrepancy between the two should be investigated and the calculation finally corrected. Finally it should be mentioned that the calculation of the voltage of earth is pre-eminently to permit of a comparison of various methods of balancing the return feeders, the other parameters (resistance of the soil, nature of the rails) remaining constant, and not to fix exactly the position of neutral zones.

2. Instead of applying the above regulation it is advisable to make certain—both by calculation (when it is a case of extending or re-arranging the network), and by tests made on the network already in use, that in no area (in the urban zone) does a mean difference of potential of over a certain value (2.5 volts for instance) exist between any two points on the rails.

3. In all cases it is to be recommended that it should be ascertained by periodical tests that the average difference of potential between the rails and other underground conduits in their vicinity remains constant, any variation being investigated so that if necessary action may be taken to avoid damage arising from the redistribution of the stray currents.

Recommendation No. 4.

Electric Drainage and Insulating Joints.

The International Telephone Consultative Committee—

Considering :—

That since the last revision of the Recommendations the use of electric drainage and of insulating joints has been largely employed in certain countries and thanks to the precautions taken these have proved satisfactory ; that the C.M.I. have accumulated considerable data on this subject ; that as a result of the information thus gathered together the reservations made in the 1931 Recommendations can partly be abandoned.

Unanimously recommends :—

That in the final revision of the Recommendations the chapter concerning electric drainage and the text relative to insulating joints should be corrected as follows :—

A. Electric Drainage.

(1) .Under the title " electric drainage " a system is indicated which includes the use of metallic conductors for connecting certain points on the sheaths of the cables which, if undrained would tend to become positive with regard to their surroundings, to the traction current return.

The object in view is to avoid any considerable flow of current from the cable to earth.

This may be obtained either by direct drainage, i.e. by leading the current flowing in the cable sheaths to the generating station by a metallic route, or by graduated drainage, i.e. by equalising in some suitable manner the potential on the cables with the potential of their surroundings.

(2) The use of direct drainage is open to the objection that it has the effect of extending throughout the cable route the zone where stray currents have a tendency to leave near-by undrained conduits. From this could result an increased risk of corrosion of the latter.

This objection can be raised when, for instance, there is a drained cable roughly parallel to a traction route and the position of near-by conduits is such that these pick up in other places current which they give up in the area where they are adjacent to the drained cable. The use of the graduated drainage system, suitably applied, is not liable to this objection.

(3) In all cases where a system of drainage is adopted, it must be used in accordance with the following principles.

(*a*) The electric drainage must allow of the regulation of the drained current so that it cannot exceed certain limits.

In the case of graduated drainage this can be obtained by the use of a suitable resistance in the drainage connections and by shunting suitable resistances across insulating joints judiciously placed along the drained conduit.

(*b*) In principle, the drainage connection should be made at the point where the potential difference between the cable and the return circuits of the traction system is highest.

(*c*) In the case of direct drainage the drainage connections will be preferably made to the negative bus-bars of the traction system generators or to the points of attachment of the return feeders. When these connections would be loo long, connection may be made to another negative point on the rail but in this case some method should be provided of breaking the drainage circuit in the case of change of direction of flow of the drained current.

In the case of graduated drainage it is normally sufficient to connect the drainage wire to negative points of the rail, suitably chosen, again taking care to supply some means of interrupting the drainage if the direction of flow of the drained current should change.

(*d*) To interrupt the drainage if the direction of flow of the drained current should change use could be made of rectifiers (copper-oxide rectifiers for example), automatic breakers, etc.

(*e*) On drainage connections it is desirable to install fuses or breakers suitable for local conditions to automatically break the connection in the case of short-circuits on the traction system.

(*f*) An effective watch must be maintained over the operation of the drainage system; periodic tests of the drainage current are necessary. For this purpose suitable provision should be

made during installation to allow of these tests being easily carried out. It is also advisable to make a periodic check of the electrical state of neighbouring conduits.

The installation at some points of the conduits concerned of a device allowing the measurement of current flowing to or from earth over a restricted area, would appear interesting especially at certain points such as track crossings.

(*g*) Any considerable modification of the construction or operation of the traction system may necessitate a corresponding modification of the drainage arrangements.

B. Insulating Joints.

(*a*) Insulating joints are employed to interrupt the metallic continuity of the cable sheath so as to prevent the passage of current from one portion of the sheath to the next.

This use may be advantageous when it is desired to separate certain sections which are particularly exposed to the exchange of current with the rails (near crossings, close parallels, etc.) from the remainder of the cable sheath in the network.

By the use of resistances shunted across the insulating joints the value of the stray current in the cable sheath can be regulated, and hence also the voltage.

(*b*) Insulating joints should be so constructed that they are mechanically sound and watertight.

(*c*) The insertion of insulating joints should be so arranged that it cannot lead to any considerable current leaving the cable sheath for earth in their neighbourhood. For this reason it is advisable that the cable sheath is insulated on the greatest possible length on each side of the joint. It is also advisable that these joints should only be installed in places which can be maintained in a reasonably dry condition.

(*d*) When several cables follow a common route, insulating joints, if necessary, must be made on each one at a common point of the route.

(*e*) Insulating joints may be of service in the case of a cable exposed to induction from alternating or direct current lines, if a sufficient continuity of sheath remains to take care of the induced alternating or transitory current. For this purpose it may occasionally be satisfactory to shunt the insulating joint by condensers or suitable reactances.

The desired result is also obtained if the cable is provided with an internal metallic sheath which is well insulated from the external sheath which is broken by insulating joints.

(*f*) The insulating joints must be inspected periodically and their efficiency checked; for this purpose they should be installed so that they are readily accessible, and during installation arrangements should be provided for making suitable tests.

PROPOSED RECOMMENDATIONS CONCERNING THE MEASURES TO BE TAKEN FOR THE PROTECTION OF CABLES AGAINST ELECTROLYTIC CORROSION.

In elaborating the present Recommendations, the C.C.I.F. proposes to gather together certain information capable of assisting the different Administrations and Operating Companies to overcome the effects of electrolysis due to return currents from electric traction.

At the present time, while it is relatively easy to detail the principle of most of the technical measures to be taken, it is scarcely possible to fix their precise limits. The measures that can be proposed can only result in a compromise between the technical aim to be attained and the economical possibilities of realising this.

It has seemed useful, nevertheless, in order to fix the ideas, to give some precise numerical values for the limits to apply to the technical measures recommended. It is in this spirit that the numerical values in the text of the Recommendations have been determined.

From another point of view the Recommendations can only be considered as expressing the opinion of the majority of the technical advisors taking part in the work of the C.C.I.F., certain Administrations and Operating Companies not accepting all the numerical limits proposed. All the questions of an administrative and economic order, and, in particular, all the questions of regulations and legislation relative to the problem of the proximity of electric traction lines and telephone cables, are outside the sphere of the Committee and have been left on one side.

In particular, the Committee has abstained from entering into details of the rules of procedure which should be followed in the reports between the Administrations and Operating Telephone Companies and the services of electric traction, production or distribution of electricity. It believes, however, that it can make a very general recommendation.

In order to obtain every advantage from the measures to be taken for the protection of telephone cables, and in order to facilitate their practical application, it is desirable that the telephone or electrical services interested should collaborate with the greatest goodwill. The reciprocal interchange, in a systematic and regular manner, of all useful information relating to the construction of existing or projected lines, to the changes of condition of operating of existing or proposed installations in the neighbourhood, is much to be recommended.

A. General.

1. According to tests made up to the present, the stray currents resulting from alternating-current installations of usual frequency do not exercise any harmful influence on metallic masses in the soil. The danger of electrolytic corrosion results only from direct-current installations.

Experience has shown that a network of pipe lines or of cables can be considered as practically free from corrosion due to stray currents, if it nowhere approaches closer than approximately 200 metres to a direct-current installation, which normally or accidentally has one conductor earthed, or to all works, structures or ducts, which are metallically connected with the said installation.*

In certain cases, however, such as that in which the earth is a very good conductor or in which a water course is present, this distance of 200 m may not be sufficient.

In their present form these recommendations apply only to corrosion caused by electric traction installations. Electric distribution installations will be subject to special recommendations.

Amongst electric traction installations themselves the recommendations do not concern traction lines with independent sub-structure, when the latter is insulated from earth throughout its entire length (wooden sleepers, special insulation at level crossings, etc.). For traction lines with independent substructure, and notably for railway lines of general interest, special recommendations will be formulated when actual data on this question have been obtained.

2. From the point of view of the danger to which underground metallic conduits are exposed, it is necessary to distinguish, in a traction network established along a road, between the region in which the pipes and the cables are at a potential less than that of the rails, where, as a result, the current enters the conduits, and that in which the conduits have a voltage greater than that of the rails and where, in consequence, the current leaves the latter.

In the following text are used the expressions " entrance zone " to designate the zone where the stray currents enter the sheath of the cables, and " exit zone " (or zone of anode corrosion), the zone where the currents leave the sheath.

3. When conditions exist so that an attack on pipes or cables by stray currents from the traction

* New tests will be made to determine, exactly, the distance at which the danger of corrosion may be considered negligible.

installation may be produced, it is necessary to apply special measures to avoid dangerous corrosion as much as possible.

4. Measures of protection should be applied in the first instance to the construction and operation of the electric traction system, the latter being the first cause of the stray currents.

Besides, these measures are generally easier to apply technically than equally effective measures applied to the cable. The latter can, in general, only be usefully applied in new installations or at the time of an important reconstruction. When installing new metallic conduits in the neighbourhood of existing or projected traction systems, these conduits should themselves be protected against corrosion by appropriate measures.

In addition, it should be remarked that, apart from the electrolytic or chemical action which they can produce, the stray currents can be harmful by themselves—for example, where at the crossing of tracks of general interest of which the rails carry signalling currents, they are capable of using these tracks. This consideration is added to the preceding ones in order to justify the necessity of limiting as much as possible the currents which pass to the earth in a power installation.

5. The measures proposed here result from a compromise between the technical aim to be attained and the economic possibilities of realising it : although they are not sufficient to overcome all danger from corrosion, they will probably ensure that the normal life of a cable will not be much reduced by electrolysis.

6. From the technical point of view it is desirable that the application of these measures be made the object of a systematic collaboration between all the interested services (electric railways, electric distribution, gas, water, etc.).

B. Protective measures applicable to electric traction networks.

Generalities.

1. Experience has shown that from the point of view of the extent of danger from corrosion it is necessary to take into account the following factors :—

(*a*) Situation and extent of underground metallic networks ;
(*b*) Nature of the track and its foundations ;
(*c*) Position of the points of connection of the return feeders to the rails.

In practice, two distinct types of traction network occur ; urban and suburban tramway systems. The first are usually characterised in the following way :—

(*a*) In practically the whole of their extent they are superimposed on underground metallic networks relatively close together (water, gas, power cables and telephone cables) ;
(*b*) The track is formed of grooved rails buried flush with the surface of the ground ;
(*c*) They are supplied by a generating station or substation placed at the centre of the points of connection to the rails of the return feeders arriving at the station.

The suburban tramways, in their turn, generally present the following characteristics :—

(*a*) They are situated in regions where underground metallic networks are few or non-existent ;
(*b*) The track is formed of flanged rails on an independent road bed ;
(*c*) They are supplied by a generating station or substation situated outside towns or their immediate outskirts.

In the case of both urban and suburban tramways the danger of corrosion will be less, the smaller the difference of potential between the rails and the earth at any point ; the efforts of the traction companies should therefore be directed towards that object. However, since the cause of electrolytic corrosion is not the voltage between the rails and earth but the current produced by this voltage, and since this current depends not only on the magnitude of the voltage but also on the leakage resistance between the rails and earth, it is clear that, other things being equal, it is not necessary to be so severe with a suburban tramway as with an urban tramway, since the track of the former is usually much better insulated from the earth than that of the latter. This is why the present Recommendations only consider the limitation of the voltage between rails and earth in the case of urban tramways.

The above having been pointed out, it should be mentioned that the conditions set out above under (*a*), (*b*) and (*c*) can be combined in various ways and that in practice networks occur which are neither urban nor suburban tramways, according to the strict meaning of the above definition, or which can be considered as either one or the other. Each particular case should be considered on its own, and the present Recommendations should be broadly interpreted.

For example, an urban tramway network, supplied by a generating or substation situated outside the town or its immediate suburbs, would be classed as an urban tramway in the district covered by the town and its immediate suburbs and as a suburban tramway outside that district, and in particular at the points of connection of the return feeders to the rails in the extra-urban zone. Inversely, a suburban tramway supplied by a generating or substation situated in a town or its immediate suburbs would be considered as an urban tramway in the zone where underground metallic networks are frequent, assuming that the tracks extend over this zone.

2. In order to reduce the amount of stray currents, an attempt should be made to :—

(*a*) Prevent current flowing into the earth by ensuring as good an insulation as possible of the traction return current system and by reducing the voltage difference between the rails and the earth ;

(*b*) Facilitate the return of current by the rails by ensuring their good conductivity.

Measures in connection with the track :—

3. It is necessary as far as possible to place the rails on a well-drained foundation of low conductivity.

All metallic contact between the rails and conducting structures (bridges, lightning rods, lamp standards, etc.) in contact with underground metallic pipe lines should be avoided.

4. As the conductivity of the rails themselves is determined by their profile it is desirable to maintain carefully the good conductivity of all joints.

5. The resistance of a joint should not exceed that of 3 m of rail, except joints at crossings and points. Further, the increase in the resistance of a section of track due to the joints should on an average not exceed 10 per cent. of the resistance of this section without joints.*

At points and crossings, joints in grooved rails are difficult of access because they are buried in the road ; furthermore, they are subjected to greater mechanical forces, in particular, the central pieces or the tongues. It is therefore not possible to apply to these joints the same regulations as those in other parts of the track. For these reasons, at points and crossings, grooved rails should satisfy the following conditions :—

(*a*) Joints, immediately after installation or after any important repair should not have a resistance greater than that of 3 m of rail ;

(*b*) Joints, which a subsequent check shows to have a resistance higher than that of 20 m of rail should be put into repair as soon as possible.

At points in the case of flanged rails the inside rails cannot be considered as participating in the conductivity, because, in general, the tongues of movable points are not shunted by electrical bonds. In the same way the central pieces of branches and crossings, in the case of flanged rails, can only be bridged by bonds of great length and consequently of high resistance. This is why it is necessary to insist that the resistance of joints in the outside lines of rails should be maintained as low as possible.

This condition is easy to fulfil as flanged rails are easily accessible. Consequently, at branch lines and crossings, the flanged rail joints satisfy the following conditions :—

(*c*) The resistance of each joint of the two outside lines of rails should never exceed the resistance of 3 metres of rail ;

(*d*) If the transverse connections satisfy the conditions of paragraph (9) the tongues of the points need not be shunted by means of special bonds.

---

* A section of track is defined as a continuous section which contains no cross-over, no points and no connection to return feeders.

6. In order to maintain the track in the best possible condition from the point of view of its conductivity, it is recommended that once a year all points and crossovers should be verified, as well as joints in sections of the track for which calculations have shown a value of mean voltage drop exceeding 0.0005 volt per metre. (The definition of mean voltage is given in paragraph 12 below.)

It is also recommended that the resistance of all other joints should be measured every five years. They should be repaired as soon as possible if the measured resistances exceed the values of paragraph 7 of this chapter.

An exception is made for welded joints which should nevertheless be examined for cracks each year. Those which are defective should be repaired.

7. To equalise the current density as far as possible in all the lines of rails of a track or of parallel tracks, transverse connections should be made.

At points and cross-overs a transverse connection should be placed between all the lines of rails, before and after the point or cross-over.

The dimensions of the transverse connections should be arranged so that the resistance measured between any two points on two parallel lines of rails does not exceed, per metre of distance between the two lines of rails in question, 1 milli-ohm in the case of grooved rails and 1.5 milli-ohm in the case of flanged rails.

Immediately before and after points or cross-overs in the case of flanged rails, this resistance should not exceed 0.25 milli-ohm.

Return feeders.

8. The distribution of potential at points on the rails can be controlled by using return feeders whose action is regulated, if necessary, either by means of additional resistances or by means of automatic boosters. The load can also be divided between several generating stations.

9. The return feeders as well as the busbars should be insulated from earth throughout their whole length. This insulation should be checked periodically. If the rails are connected to the negative terminal of the generators, it is necessary to choose as far as possible for the connections of return feeders situations where the earth is dry and distant from large pipes and cables, since it is in the neighbourhood of these points of connection that the danger of electrolytic corrosion is most pronounced.

10. The connections between return conductors and rails should be maintained in good condition.

Polarity of contact wires.

11. It is possible to reduce the danger of corrosion by means of the voltage of the contact wires.

When the positive pole is connected to the contact line, the zones of anodic corrosion are found in the neighbourhood of the points of connection to the return feeders. When the negative pole is connected to the contact line the zones of anodic corrosion are distant from these points and, in addition, these zones tend to follow the movements of the tramcars.

In order to reduce the harmful effect of stray currents, use may be made either of a periodic reversal of the polarity of the contact wires (which, in the case of a daily reversal, can produce a reduction of three-quarters) or of a three-wire system of supply.

The best condition in each case can be chosen from a study of the local conditions.

It should be noted that the reversal of the polarity of the contact wires raises certain operating difficulties in the case of networks supplied from several sub-stations. In addition, in large towns in which separate networks occur having crossing points, the adoption of this measure for one of the networks necessitates the use of special arrangements to ensure the insulation of this network with respect to the others at points of crossing.

Justifying Calculations.

12. In order to verify whether the arrangements taken to ensure the return of current are satisfactory (in particular the choice of locations for the connections of return feeders and the distribution of potentials), calculations can be made to see whether the mean voltage drops along the rails and the differences of mean potential between the rails and earth* remain within the limits given below. The principle of the method of calculation is indicated in Appendix I.

13. On any section of the track of an urban tramway, the mean drop of voltage per metre, calculated on the assumption of an increase of rail resistance of 10 per cent. at the joints (see paragraph 6), should not be greater than 0.001 volt.

14. The mean voltage drop per metre of a section of the track of a suburban railway calculated as indicated in paragraph 12 should not exceed 0.0012 volt in sections on roads and should not exceed 0.0014 volt in sections with independent road bed.

15. The mean voltage drop between two points of a tramway (urban or suburban) should not exceed a number of volts equal to twice the distance in a straight line between these two points expressed in kilometres.†

16. In zones of territories supplied by an urban tramway where stray currents leave pipe lines or metallic cable sheaths, the mean differences of potential calculated between rails and earth should not exceed 0.8 volt along sections of rail having a small resistance to earth (e.g. buried rails).

For sections with a high average resistance to earth (e g. flanged rails on a separate road bed) it is not necessary to limit the mean difference of potential between rails and earth.

Methods of electrical measurement.

17. Measurements carried out in accordance with the methods given in Appendix 2 permit the state of the network to be verified in practice. They constitute an approximate check on the results of the calculation of voltages or mean differences of potential.

For very extensive networks, for which the calculation in accordance with paragraph 12 would be too complicated, measurements are indispensable to verify whether their condition conforms with the regulations of paragraphs 13, 14 and 15.

C. Protective measures applied to underground cable networks.

1. In order to avoid electrolytic corrosion it is necessary to attempt to reduce as much as possible the flow of stray currents in the cable sheaths in an electrolytic medium. To do this it is necessary principally, to reduce the intensity of the stray currents flowing in cable sheaths by increasing the insulation of the sheaths with respect to earth and with respect to the traction network. In certain cases, on the contrary, it may be advantageous to provide a metallic path in order to prevent the flow of current direct from the sheath to the electrolytic medium.

2. The cables should be placed as far as possible from tramway installations; the crossings of the tramway lines being the dangerous points, it is necessary to reduce their number as much as possible.

3. When studying cable routes, it should not be forgotten that certain soils favour electrolytic corrosion (especially dampness, organic substances, soluble alkalis, bases and acids, etc.).

---

* The differences of mean potential or mean voltage drop are defined as the values obtained by calculations for the different sections of track, taking as the power in a given section, the mean power, i.e., the number of kilowatts obtained by dividing by 24 the number of kilowatt-hours supplied on the average to the contact wire during a working day.

† Although the conditions of paragraphs 13 and 14 seem to be sufficient from the point of view of electrolytic corrosion, other considerations such as telegraphy or signalling on telephone lines with earth return make it desirable to fix a maximum limit for the difference of instantaneous voltage between any two points on the tramway line.

4. All metallic contact between the cable sheaths and conducting objects or structures in connection with the tracks of traction systems should be avoided.

5. It is necessary to avoid as far as possible infiltrations and stagnant water in the conduits as well as in the connection boxes or in the manholes.

6. In manholes and in terminal boxes, as well as at junction points, bare cables should be connected together by means of metallic connections soldered to the sheaths.

In cases where the underground conduits containing telephone cables are constructed of metallic pipes, these should also be connected electrically at these points.

7. A simple layer of insulating paint or a thin insulating covering provides very little guarantee against penetration by water, and cannot provide a permanent protection against corrosion. Such insulating layers are often found to be dangerous, since, after a certain time, at points which have become uncovered, a more intense corrosion takes place.

8. When the insulating sheath which covers the cable sheath is sufficiently thick and is itself protected, both from the mechanical and from the chemical point of view, by armouring or by some similar arrangement (cable sheath, conduits of Zores iron, etc.), the protection against electrolytic corrosion can be considered sufficient. Such means of protection are recommended, particularly in the following cases: crossings by cables of tramway lines, crossing over metallic bridges, proximity to metallic structures connected more or less to the track.

9. It has been proposed to increase the electrical resistance of cable sheath by installing insulating joints with a view to preventing electrolytic trouble. These insulating joints should only be installed at points where the ground is sufficiently dry. They should be made so as to give mechanical resistance, durability and imperviousness.

In the case of several cables placed in the same conduit and arriving at the same point, the final use of insulating joints should be made for all of them. Their use should be avoided for cables subject to serious induction from direct or alternating current lines.

10. Earth plates buried in the earth and connected to the cable sheath (déversoirs) present several of the disadvantages of drainage connections*; it is advisable to restrict their use to points where the current leaves the cable sheath, and never to use them in regions where it is not possible to ensure that the earth plate will never be positive with respect to the cable sheath.

It does not seem that this procedure should be recommended for the protection of cables against electrolysis due to return currents from traction networks, a change in the distribution of these currents (produced, for example, by a modification in the traction network) being capable of modifying the polarity of some of these earth plates with respect to the cable sheath.

D. Protective measures by means of electric drainage.

1. Under the heading of electric drainage is included a system comprising the use of metallic conductors for connecting to the return current network of the traction system certain points of the cable sheath which without drainage would tend to become positive with respect to the earth. The object is to conduct by a metallic path to the generating station the current which flows in the cable sheaths in such a manner as to decrease the amount of current which leaves these sheaths and enters the earth.

2. The use of drainage raises a certain number of different kinds of objections:—

This practice is very costly (cost of installation, of maintenance and of inspection high).

It can become ineffective as a result of accidental alteration in the distribution of the currents

* See Section D in connection with this subject dealing specially with electric drainage.

circulating in the cables; in particular the magnitude of these currents can become too great; on the other hand, cable may be exposed to cathode corrosion at places where the earth is of an alkaline nature.

It can become a cause of danger to telephone installations when a short circuit is produced on the traction network, and a cause of danger to the personnel dealing with the maintenance or operation of the telephone cables when the continuity of the rails has become broken by accident.

Finally, drainage, having as its effect the increase in the extent of the return current network of the traction system in all directions, can increase considerably the probability of corrosion at some point in the cable network or in neighbouring metallic conduits.

3. However, these disadvantages can be considerably decreased in certain cases—for example, when only a single traction line exists and where the route of the telephone cables is parallel to this track and has no branches. In such a case drainage connections can be permitted on the condition that a relatively small quantity of current is drained; this quantity should not exceed that which is necessary to prevent the harmful effect of electrolysis.

4. In all cases where a drainage system is adopted it is necessary that this system should be established in accordance with the following principles :—

(*a*) The most convenient point for making the connection to the cable sheath is the point where measurements show that the current leaving the cable to enter the earth has the greatest possible value. It is necessary, in order that the drainage shall be satisfactory, that the potential of points where the connections are arranged, which were positive with respect to the earth before the adoption of this measure, should become, on the contrary, lower than the voltage of the earth in the neighbourhood.

(*a*) Drainage connections should only be installed at the negative busbar of the traction current generator or at points where the return feeders are connected to the rails.

(*c*) The drainage should be arranged in such a way that the cable sheath being drained has throughout its length a negative potential with respect to the earth.

(*d*) It is essential to reduce all drainage to the minimum necessary for the protection of telephone cables. This can be done either by the choice of a suitable section of the conductors used for the drainage or by the use of additional resistances.

(*e*) An effective watch should be kept in order to check the conditions of operation of the drainage system : periodical measurements of drainage current are necessary. To this end all useful arrangements should be taken during the installation of the system to enable these measurements to be carried out easily.

(*f*) It is equally necessary to take care of the possibility of being able to interrupt the drainage connections at all times, when, apart from this precaution, currents could circulate of reverse polarity and of magnitude or of duration capable of leading to damage.

(*g*) It is necessary, finally, to install fuses in drainage connections or to use circuit breakers adapted to local conditions in order to interrupt the connection in case of short circuits on the traction network.

APPENDIX I.

TO THE RECOMMENDATIONS CONCERNING THE MEASURES TO BE TAKEN FOR THE PROTECTION OF CABLES AGAINST ELECTROLYTIC CORROSION.

PRINCIPLE OF THE METHOD TO BE FOLLOWED FOR CALCULATING THE DISTRIBUTION OF RETURN CURRENTS IN A TRAMWAY NETWORK.

In order to avoid electrolytic corrosion it is necessary to reduce, as far as possible, differences of potential between different points of the rail and the earth.

This is obtained particularly when the sections of track carrying too great a value of current are discharged conveniently by means of return feeders of sufficient cross-section connected to the rails at properly chosen points. The method of calculation indicated here serves as a guide in the choice of these arrangements.

It would be possible to determine exactly the distribution of return currents in the rails and in the earth as well as the distribution of potentials, if the following information was known :—

The geometric configuration as well as the electrical characteristics of the track network.
The position of the return feeders as well as their electrical characteristics.
The insulation resistance of the rails with respect to earth at each point of the track network.
The conductivity of the earth at each point.

Finally, the values at each instance of the current entering the rails at each point of the network where there is a locomotive. It is evident, also, that these values of current entering the rails depend on the configuration of the feeder network and the electrical characteristics of this network, as well as on those of the machines, and, finally, on all the data given above.

Nevertheless, as the effects of electrolysis depend, not on the instantaneous values of the current, but on their integral with respect to time, it is sufficient to take into account in the calculations the mean values of the current.

It should be remarked that certain of the data necessary for the exact solution of the problem cannot be known. Nevertheless, in practice the approximate solution is relatively easy of calculation, and permits a sufficiently exact idea to be obtained of the distribution of the potential which determines the extent of the electrolytic action.

It is possible in effect to assume, in order to simplify the calculations as far as concerns the electrolytic effect, that everything takes place as if the mean values of the current supplied to the rails by the generators had the same value per unit length at all points in the same section of track.

The values of these currents that must be introduced into the calculation can be deduced, either from the readings of instruments installed in the locomotives, if it is a question of a system already established, or, in general, from empirical relations giving the consumption of the machines as a function of the weight transported, of the speed, of the gradient of the track, etc.

In addition, for a first approximation, as long as the distribution of currents in the rail network and the distribution of potential along this network are studied, it seems permissible to neglect the losses of current along the rails.

These losses are small in general, and, in addition, the better the network is established the smaller are these losses.

The only effect of neglecting these losses will be that the differences of potential determined between the points and the rail will be larger than those present in reality.

Experience has shown that when the differences of potential calculated under these conditions do not exceed the value of 0.8 volt specified in paragraph 16 of Section B of the Guiding Principles, the damage caused by the corrosion is reduced to permissible limits.

In any case, if it is assumed that the losses of current in the earth are negligible, the presence of the earth can be neglected in the calculation of the distribution of currents in the rail network and of the distribution of potentials along this network.

This calculation can be made in the following manner :—

1. The mean linear density of the feeder current is known at each point of the rail network. The value I of the total current entering the whole network can thus be determined.

2. Currents entering the rail network can only leave by the feeders ; the sum of the currents leaving by the feeders is thus equal to I.

3. Suppose, to start with, that there exists a single feeder F_1 of known position. Knowing the value of the current entering at each point, and also the value of I_{F1} of the current leaving by the feeder, which in this case is equal to I, we can determine absolutely (and independently of all electrical characteristics of the feeder) the value of the current which passes each point in the rail network. This determination is made by means of Kirchhoff's laws. By applying Ohm's law the value of the potential at each point is obtained, the potential of reference being that of a point chosen arbitrarily.

Let M be any point in the rail network.

Assume the following symbols :—

I_{M1}, the mean value of the current passing the point M,

V_{M1}, the mean potential at this point (the second index 1 indicates that I_{M1} and V_{M1} have been calculated on the assumption that all the current I leaves by the feeder F_1).

4. This being so, consider the case where p feeders are used, F_1, F_2, F_i, F_p, of which the position is known.

The preceding calculations can be repeated for each feeder, assuming that it exists alone.

Denote by :

I_{M1}, I_{M2}, I_{Mi}, I_{Mp}, the different values of current which passes the same point M of the rail network.

V_{M1}, V_{M2}, V_{Mi}, V_{Mp}, the different values of potential of the same point M (the potential of reference being that of an arbitrary point, but the same in all cases) calculated on the assumption of the existence of a single feeder.

It is important to note that these quantities can be calculated once and for all from the values of current entering the network and the position of the feeders, independently of all electrical characteristics of the feeders.

This having been done, denote by I_{F1}, I_{F2}, I_{Fi}, I_{Fp}, the values of currents leaving feeder F_1, F_2, F_i, F_p.

We have, therefore :—

$$\sum_{i=1}^{i=p} I_{Fi} = I \qquad \text{.....(1)}$$

Also the value of current at a point M will be equal to :

$$I_M = \frac{\sum_{i=1}^{i=p} I_{Fi}\, I_{Mi}}{\sum_{i=1}^{i=p} I_{Fi}} \qquad \text{.....(2)}$$

The value of potential at point M will be :

$$V_M = \frac{\sum_{i=1}^{i=p} I_{Fi}\, V_{Mi}}{\sum_{i=1}^{i=p} I_{Fi}} \qquad \text{.....(3)}$$

5. Thus, on the assumptions made up to the present, the knowledge of the value of the currents leaving each feeder permits the complete determination of the distribution of current in the rail network as well as the distribution of potentials.

In the application we can start from different data, according to the object of the study. We can thus start with the value of the current which leaves the rails at each feeder. In order to obtain this result effectively, it is necessary to determine the electrical characteristics of the feeders in such a way that they satisfy certain conditions.

Let R_1, R_2, R_i, R_p, be the resistance to be given to each of the feeders.

Denote by V_1, V_2, V_i, V_k, V_p, the values of potential at points 1, 2, i, k, p, where these feeders are connected to the rails.

According to the general equation (3), the expression for this is :—

$$\left.\begin{aligned} V_1 &= \frac{\sum_{i=1}^{i=p} I_{Fi}\, V_1}{\sum_{i=1}^{i=p} I_{Fi}} \\ V_k &= \frac{\sum_{i=1}^{i=p} I_{Fi}\, I_{Mi}\, V_k}{\sum_{i=1}^{i=p} I_{Fi}} \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(4)$$

As all the feeders are connected to the same busbar at the generating station, we must have :—

$$V_1 - R_1 I_{F1} = V_k - R_k I_{Fk} = V_p - R_p I_{Fp} \quad \ldots\ldots\ldots\ldots\ldots\ldots(5$$

These p equations (4) and these $(p-1)$ equations (5) are not sufficient to determine the $2p$ unknowns (values of V_k and values of R_k). We can, therefore, for example, fix the arbitrary value of one of these unknowns.

It should be noted that it is nevertheless necessary, in order that the integral solution should have a physical meaning, that the values found for the different resistances should be positive.

We can also determine the distribution of return currents in the different feeders in such a way that the points where all the feeders are connected to the rails are at the same potential.

The system of equations to be solved is thus :—

Relation (1).

The p equations (4).

To which must be added the $(p-1)$ equations (5) and (6).

$$V_1 = V_2 \ldots = V_k \ldots = V_p \quad \ldots\ldots\ldots\ldots\ldots\ldots(6)$$

There are thus the total of $(2p)$ equations to calculate $2p$ unknowns (the values of I_{Fk} and of V_k). The solution of the problems is thus completely determined.

We can finally determine what is the distribution of currents in the rail network when the return feeders have a resistance determined in advance.

Let V_k be the value of potential at a point where feeder F_k is attached ; R_k the resistance of this feeder.

The system of equations to be solved is therefore :

Relation (1).

The p equations (4).

The $(p-1)$ equation (5).

There are thus $2p$ equations to calculate $2p$ unknowns (the values of I_{Fk} and of V_k). The solution to the problem is again determined.

6. In any case, when the values of the current leaving by each feeder are determined we can, by means of equation (3), calculate the distribution of potentials along the rails, the potential of reference being that of an arbitrary joint chosen at the start. This permits us to ensure that the mean

drop in potential per metre, and the mean drop of potential between any two points of the networks, shall not exceed the limiting values indicated in paragraphs 13, 14 and 15 of Section B of the Recommendations.

It is interesting to know, in order to determine the importance of circulating currents in the earth capable of producing electrolysis, the difference of potential existing between the rails and the earth. In fact, the value of the current density leaving the rails to enter the earth, or leaving the earth to re-enter the rails, is at each point proportional:

To the difference between the potential of the rail and the potential of the earth.

To a certain co-efficient representing the losses of the track with respect to the earth.

Denote by i_M the density at any point M of the current leaving the rails to enter the earth. If at this point the current leaves the earth to re-enter the rails, i_M will be negative.

Let V_M be the potential of the rail at point M and V_{M_0} be the potential of the earth in the neighbourhood of point M, measured with respect to the potential of reference which has already been mentioned.

Let C_M also be the coefficient of leakance of the track at point M per unit length of track.

We have therefore :—

$$i_M = C_M (V_M - V_{M_0}) \quad \ldots\ldots (6a)$$

Nevertheless, the variations of potential of the earth along the rails of an electric traction network are always considerably smaller than the variations in potential of the rail itself.

We can thus see that only a small error in the expression for the current density flowing between the rails and the earth is produced when we give the same value V_0 to the potential of the earth at all points.

When it is a question of a network of which one of the points is connected to a good earth point we should evidently assume that the potential of this point is exactly equal to the potential V_0.

When, on the contrary, it is a question of a network not having at any point a direct connection to earth, and having well insulated feeders, we can determine the mean value V_p of the potential of the earth from the following considerations :—

We know that in such a case the sum of the currents leaving the rails towards the earth is equal to the sum of the currents returning to the rails—in other words, the algebraic sum of all the currents leaving the rails (or returning to the rails) is zero.

This condition is as follows :—

$$\int C_M (V_M - V_0)\, dl = 0 \quad \ldots\ldots (7)$$

The integral being taken over the whole length of the network of rails.

From this we obtain :—

$$V_0 = \frac{\int C_M V_M\, dl}{\int C_M\, dl} \quad \ldots\ldots (8)$$

In connection with the values to be given to the coefficients of losses C_M, experience has shown that we can assume that these coefficients keep the same value throughout the whole length of a network if the same type of rail is used throughout, and if the rails are installed throughout in the same way. In such a case the coefficients are eliminated from formula (8). When this is not the case,

it is convenient to divide up the total network into regions within which we can give these coefficients a uniform value. It is sufficient, however, for the calculation that these coefficients be determined by an approximately constant factor.

We can, for example, adopt the following values for C :—

$C = 1$ for a double track with grooved rails.

$C = 0.7$ for a single track with grooved rails.

$C = 0.1$ for a single track with flanged rails.

Thanks to these circumstances, we can determine for formula (8) a more complete expression.

Consider the section of track (in the sense defined in the Recommendations) or, more precisely, the part of a section of track for which we can give C a uniform value.

Let A and B be the extremities of this part of the section.

L the length of the section.

J the mean value of the total feeder current entering the section.

V_A and V_B, the potential of the points A and B measured with respect to the potential of reference which has already been mentioned.

For this part of the section we obtain integral :—

$$\int_A^B V_M \, dl$$

But if l is the distance separating the point M from the point A, we have from Ohm's law :—

$$V_M = V_A + r \int_A^M \left(I_A + J \frac{l}{L} \right) dl$$

r representing the resistance of the track, I_A the current flowing in the track at the point A (positive in the direction of B towards A).

We have :—

$$V_M = V_A + rl \, I_A + r \frac{J}{L} \frac{l^2}{2}$$

In particular :—

$$V_B = V_A + rL \, I_A + r \frac{J}{L} \frac{L^2}{2}$$

From which :—

$$\int_A^B V_M dl = L \left(V_A + r I_A \frac{L}{2} + r \frac{J}{L} \frac{L^2}{6} \right)$$

$$= \frac{L}{2} (V_A + V_B) - \frac{L^2}{12} rJ.$$

In general, even for a rather long section, the term of the second degree in L is negligible. There remains, therefore :—

$$\int_A^B V_M \, dl = \frac{L}{2} (V_A + V_B)$$

and the expression for V_0 can be written

$$V_0 = \frac{\sum CL \, (V_A + V_B)}{2 \sum CL}$$

the summation being extended over all the sections of the traction network.

When the preceding calculations have been made we can form for each point of the network the difference $V_M - V_0$, and make certain that at no point do these differences exceed the value of 0.8 volt indicated in paragraph 16 of Section B of the Recommendations.

If this is not so, it signifies that the number of return feeders is too small or that the resistances of these feeders are not efficiently arranged; or, further, that the location of the connection points of the feeders to the rails has not been properly chosen.

It is necessary, then, to study as above the configuration of the feeders or of the rails satisfying the given conditions.

APPENDIX II.

TO THE RECOMMENDATIONS CONCERNING THE MEASURES TO BE TAKEN FOR THE PROTECTION OF CABLES AGAINST ELECTROLYTIC CORROSION.

Electrical Measurements in Connection with Electrolytic Corrosion.

Electrolytic corrosion being due to stray currents which leave the metallic sheaths of cables, it is desirable to measure directly the intensity of the stray currents in the sheaths themselves or in the earth at the points where these currents enter or leave. There are different methods, of which a number are mentioned below, for carrying out these measurements.

On the other hand, stray currents are caused by differences of potential which exist between the rails and the sheath, and whose importance, other things being equal, is greater, the greater the resistance of the track. Consequently, it is desirable, in order to determine the conditions of a tramway network, to proceed to measure the differences of potential and the drop in voltage, and to measure the resistance of the rail joints.

I.—Measurements of the Stray Current Intensity.

A.—In the metallic cable sheath,
B.—In the earth at the point of entering and leaving the metallic cable sheath.

A.—Measurements of the intensity of the stray currents in the cable sheath.

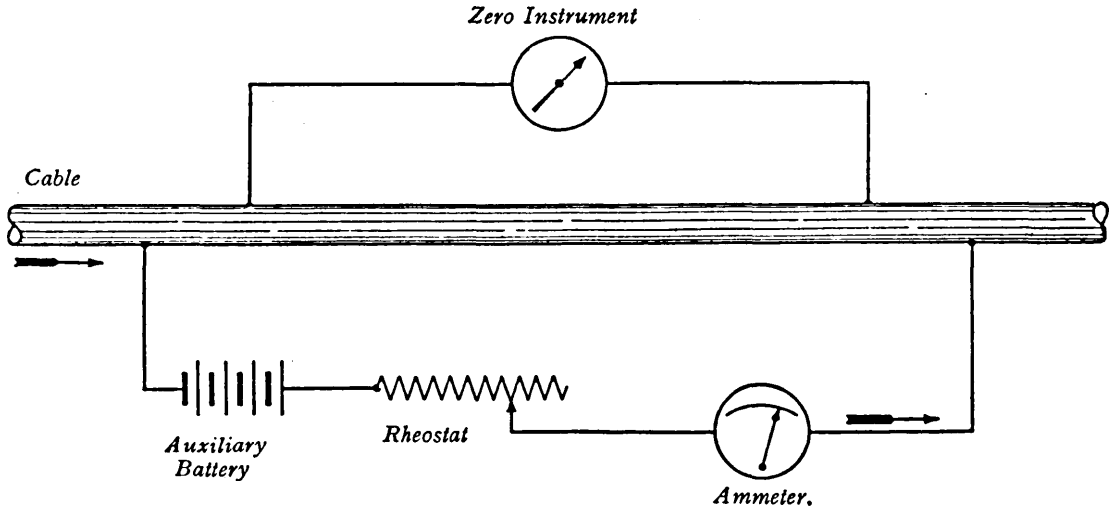
The intensity of the currents which flow in the metallic sheath of a cable can be measured by one of five methods:

1. The intensity of the stray current flowing in a given length of the sheath can be deduced from the measurement of the difference of potential drop between the two extremities, after having calculated the electric resistance of the given length of sheath from the geometric dimensions and the resistivity of the metal. This method, however, gives rise to error because of the irregularity of the sheath, and because of the damping of the oscillation of the voltmeter shunted by the small resistance of the sheath.

2. In order to measure the stray currents flowing in the metallic sheaths of the cable, this sheath can be interrupted and an ammeter of as small a resistance as possible connected (in practice from $\frac{1}{100}$ to $\frac{1}{10}$ of an ohm).

3. In order to avoid breaking the continuity of the metallic sheath of the cable, the current which circulates in this sheath can be compensated by means of an auxiliary battery associated with the rheostat and an ammeter. A sensitive measuring instrument with a short period of oscillation,

preferably pivoted (zero instrument)* ; enables it to be determined when this compensation has been properly obtained. The connections are shown below :—



Note : For this zero instrument a galvanometer which is sensitive to differences of potential at the terminals should be used having a short transitory period, owing to the rapid variations in the magnitudes of the stray currents which flow in cable sheaths liable to corrosion. On the other hand, the sensitivity of the galvanometer to current need not be particularly great. Consequently, a low resistance galvanometer is better for these tests than a high resistance galvanometer.

The German Telephone Administration generally uses a direct reading pivoted galvanometer having a resistance of about 5 ohms and a sensitivity (with respect to the applied voltage) such that one scale division corresponds to a potential of 30 microvolts, which is sufficient for the majority of cases encountered in practice. A galvanometer is available which has a sensitivity twice as great, also the Zeiss moving coil galvanometer whose sensitivity is 10 to 100 times greater ; the resistance of this last galvanometer reaches 5 to 10 ohms ; with the Zeiss galvanometer it is possible to measure currents in pipes where the intensity is only a few milliamperes.

Mirror galvanometers, which are used in communication work only for the measurement of insulation, have a sufficient sensitivity but their transitory period is too long. Direct reading suspension galvanometers which are also sometimes used for insulation measurements usually have insufficient sensitivity from the point of view of applied voltage.

The British Administration use an instrument called the " No. 36 Tester " for measuring currents in cable sheaths.

(1.) A voltmeter with three centre zero scales.

1.25 — 0 — 1.25 millivolt.
25 — 0 — 25 millivolts.
250 — 0 — 250 ,,

When the 250 millivolt scale is used the resistance is 2000 ohms.

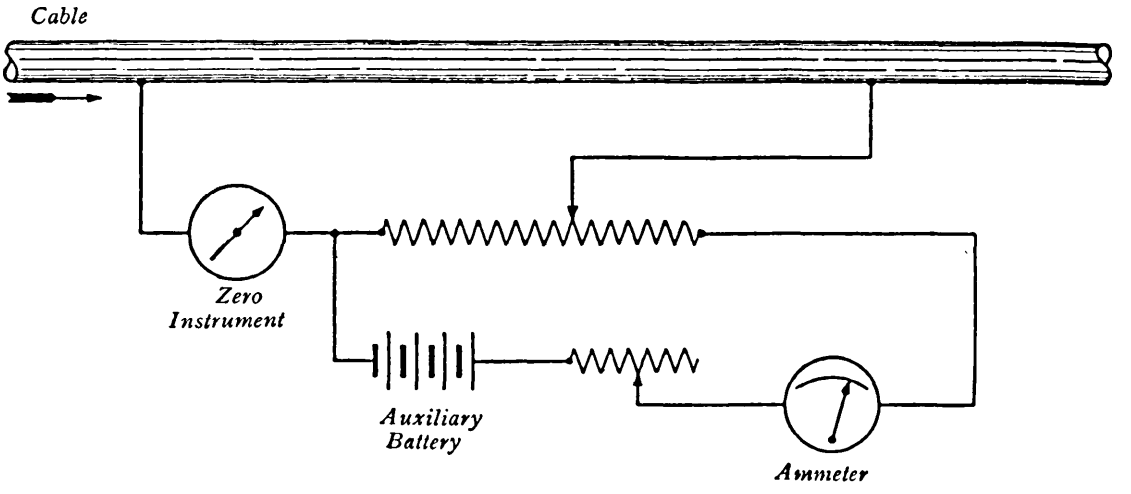
(2.) An ammeter with three scales.

0 — 50 milliamperes.
0 — 500 ,,
0 — 5000 ,,

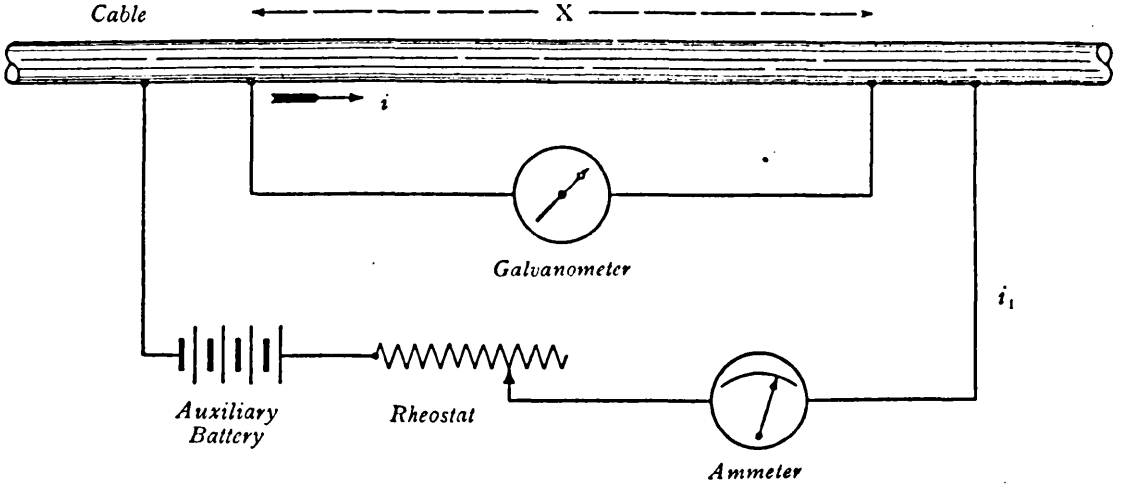
* See note.

When the 50 milliampere scale is used the resistance is 0.216 ohm, with corresponding values for the other scales.

4. Instead of compensating the currents, the voltage along the metallic sheath of the cable can be compensated for according to the following, but it is then necessary to calculate the currents which flow in the sheath, knowing the resistance of the sheath.



5. Finally, the value i of the current flowing in the cable sheath and the resistance X of the sheath can be deduced from two successive readings on a galvanometer connected to the two extremities of the sheath. Arrangements of the connections are shown below, and the theory is as follows. Let i be the intensity of the stray current in the cable sheath at the instant of measurement.



On this current another current i_1 is superposed provided by a battery and measured by an ammeter. The current i_1 is as big as possible and the resistance of the rheostat is so big that the stray current is not shunted appreciably by it. The deflection d is read on the galvanometer. The terminals of the battery are quickly reversed and a new deflection d' is read.

If k denotes a numerical coefficient depending on the galvanometer, then :—

$$(i + i_1)X = kd$$
$$(i—i_1)X = kd'$$

from which is obtained :—

$$i = i_1 \frac{d + d'}{d—d'}$$

$$X = k \frac{d—d'}{2i_1}$$

B.—Measurements of the intensity of stray currents in the earth at the point where they enter or leave the cable sheath.

Experience has shown that a current of 0.75 mA per dm^2 of an iron pipe is dangerous from the point of view of corrosion of this pipe. The corresponding value for lead sheaths is in inverse proportion to the electrolytic equivalent of iron and lead. There are three methods of measuring this current.

1. The Haber method, which uses two non-polarisable electrodes of known area buried in the earth at a known distance one from the other and connected to a milliammeter. This method only gives the mean value of the density of the stray currents in the earth, and, further, the use of these plates alters the distribution of the stray currents in the earth.

2. A method at present being studied in Switzerland uses non-polarisable electrodes of small dimensions placed in a small trough which has been constructed in the earth near the cable.

This method allows measurements to be obtained for each position of the electrodes in the trough : (1) the current which circulates between them through the earth, and (2) the specific resistance of the part of the earth between these electrodes. From this a complete investigation can be made of the stray current paths.

3. Another method used in Germany makes use of a metallic electrode connected to the metallic sheath of the cable by a milliammeter. A cylinder is employed for the electrode having a known surface taken from the sheath identical to that of the cable and filled with tar. After waiting for a short time a reading of the milliammeter is taken in order to allow the accumulator, consisting of the electrode and the sheath, to discharge.

II.—Measurements of the Differences of Potential and Drop in Voltage.

In order to measure the difference of potential between a point of the rail and a point in the metallic sheath of the cable a high resistance milli-voltmeter is used and is connected to two contacts. In order to avoid error due to humidity, these contacts are preferably of the same metal as the objects with which they are in contact. The contacts should be as good as possible and have as small a resistance as possible. It is an advantage for the measuring instrument to have a zero at the centre of the scale ; the moving part should have a very small oscillation period.*

It is desirable in this measurement to take into account the E.M.F. of the local electrolytic couple consisting of the two contacts of different metals.

In order to measure the drop in voltage between two points on the rail similar arrangements are

---

* For measuring the difference of potential between cable and earth and between cable and rail the British Administration use the No. 26 voltmeter, which has three centre zero scales :—

0.25—	0 —	0.25 volt—	resistance	1 000
2.50—	0 —	2.50 „ —	„	10 000
12.5 —	0 —	12.5 „ —	„	50 000

In addition, the British Administration uses for electrolysis tests a Zeiss galvanometer with the following characteristics :—

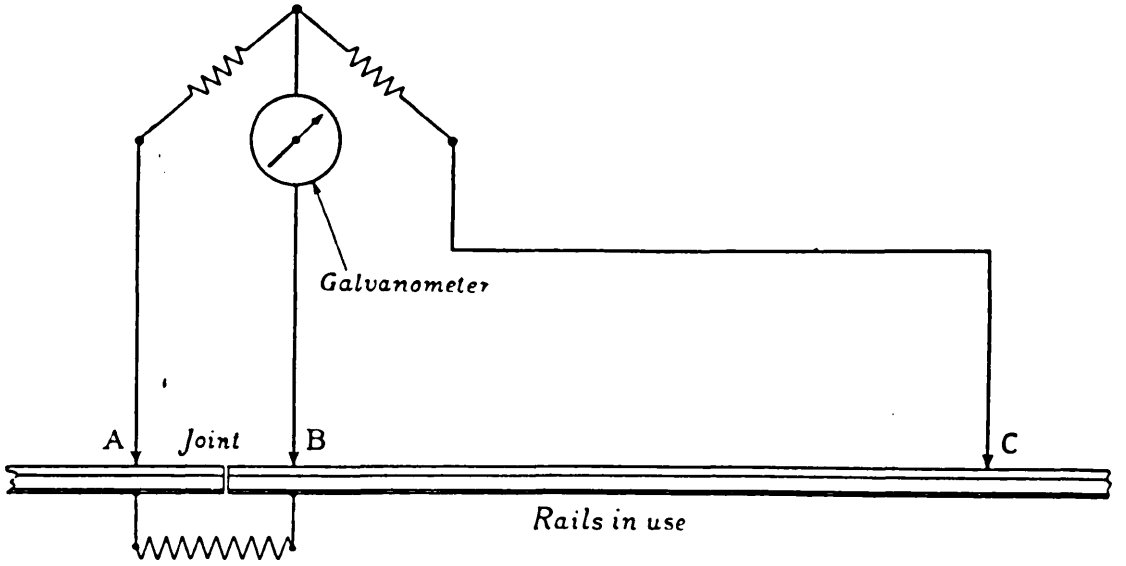
The resistance is from 5 to 7 ohms, a current of 3×10^{-7} A gives a deflection of a division read with a microscope having a magnification of 80. These galvanometers are usually employed to give a continuous record on a photographic film.

used ; no correction is required because the contacts are of similar metal. When the two points and the track between which the drop in voltage is to be measured are sufficiently far apart, use is made of pilot wires, which make it necessary to introduce a correction factor to take into account the resistance of these wires.

III.—Measurements of the Resistance of Rail Joints.

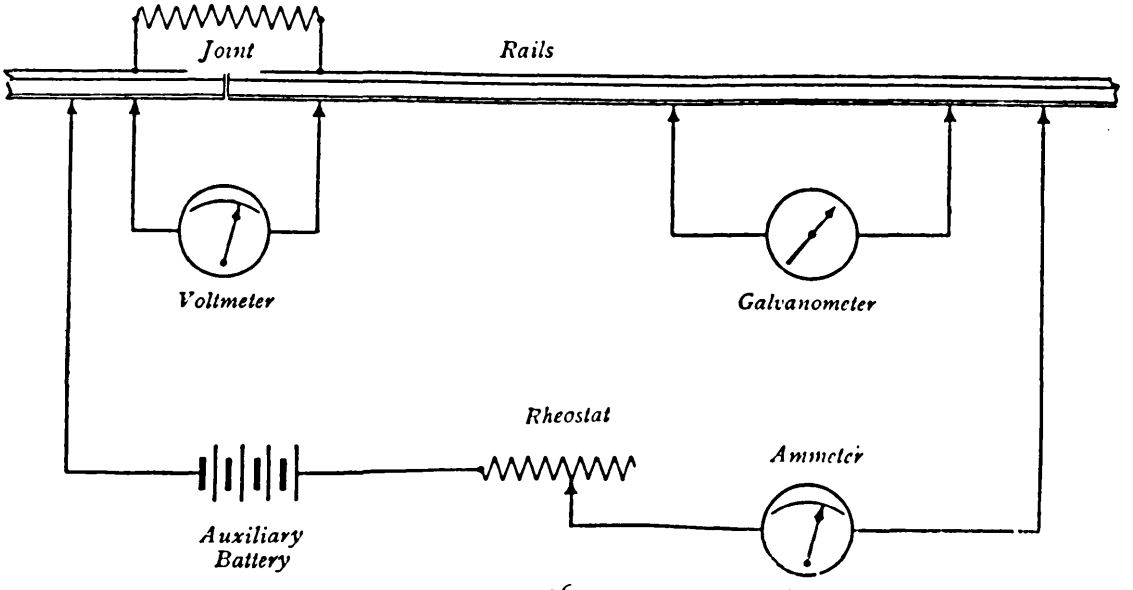
Two methods exist, using respectively, a Wheatstone Bridge, and a comparison method.

1. *Wheatstone Bridge method.*—The resistance *A*—*B* of the joint is compared by means of the Wheatstone Bridge with the resistance *B*—*C* of a certain length of rail. The difference of potential produced between the joints *A* and *C* by the traction current which flows in the rail serves as a battery ; a galvanometer is used as a zero instrument.



2. *Comparison method.*—The arrangement of the method is as follows :—

The measurement is made when there is no traction current circulating in the rails. An auxiliary battery, a rheostat, a voltmeter and a galvanometer are used. The rheostat is regulated in such a way that the deflection of the galvanometer is constant and well determined. In this case the reading of the voltmeter, in which the scale is calibrated in metres of rails, indicates directly the resistance of the joint as an equivalent length of rail.



PART 3.

PROTECTION OF TELEPHONE CABLES AGAINST CHEMICAL CORROSION.

PROPOSED RECOMMENDATIONS CONCERNING THE MEASURES TO BE TAKEN FOR THE PROTECTION OF CABLES AGAINST CORROSION DUE TO CHEMICAL ACTION.

Definition.—A metal suffers from self-corrosion when its surface corrodes and is covered with a non-adherent product. When the latter has been removed we usually find that the metallic object has lost a part of its weight.

Principal Causes of Chemical Corrosion.

Lead can be attacked by bases as well as by acids. Nevertheless, it is one of the most resistant metals from a chemical point of view.

The lead should enter into direct contact, neither with pure cement, nor with water containing lime, nor with alkaline bodies. Cinders are equally dangerous. Chemical corrosion can also be produced in certain soils when there exist organic acids resulting from the decomposition of wood or other vegetable matters. Certain kinds of wood appear to attack the lead ; it has been noticed that oak in particular produces corrosion. Sewer water is harmful. Lead does not dissolve in hard water ; but soft water, in particular, marsh water containing organic acids, attacks it.

Lead and Alloys.

Telephone cables are contained in lead sheaths of three different types :

(*a*) Commercially pure lead.
(*b*) An alloy containing 1 to 3 per cent. of tin.
(*c*) An alloy containing 1 per cent. of antimony.

It is not possible at the present time to state which of these three types of cable sheath is the most resistant to chemical corrosion, the data received on this subject being contradictory. However, it is certain that alloys present a superiority as regards mechanical resistance.

Rules Relating to the Installation of Cable Circuits.

(*a*) *Cables in the Earth.*—Unless they are covered with a protective coating or with chemically inert material, lead cables should not be placed directly in the soil.

(*b*) *Cables in Conduits.*—The choice between different kinds of conduits (iron tubes, concrete, sand, stone, wood, etc.) is made chiefly from technical and economic considerations ; cables in conduits are usually sufficiently well protected against chemical action from constituents of the soil.

A thick covering of vaseline applied to the surface of the cable sheath at the time of installation will assist in preventing chemical corrosion.

The conduits should be made as water-tight as possible without incurring unjustifiable expense.

If it is impossible to protect the conduit against infiltration of harmful liquids, it is necessary to place the cables in a sheath which has been covered with a protective layer impregnated with a preservative compound.

All necessary arrangements should be made to guarantee and maintain this layer perfectly water-tight.

A lengthy test has shown that with a well-constructed conduit of concrete, of which parts have been sufficiently dried to start with, and provided in the interior with a chemically inert coating, the damage is practically negligible from the point of view of operation and maintenance.

If wood conduits are used, these should be previously impregnated with a preservative substance which does not attack lead.

APPENDIX

TO THE RECOMMENDATIONS CONCERNING THE MEASURES TO BE TAKEN FOR THE PROTECTION OF CABLES AGAINST CORROSION DUE TO CHEMICAL ACTION.

Method for Determining whether Corrosion is Chemical or Electrolytic.

When placing cables in conduits or in pipes, any direct contact between the sheath and the soil should be avoided, but it is impossible to prevent infiltration of water : this water may come from the surface of the earth and penetrate into the conduits by the inspection holes or at the points where the conduits are connected together ; it can evidently contain, in variable quantities, the bodies existing in the neighbouring soil ; in any case of corrosion it is necessary to see whether the damage is due to chemical corrosion or to electrolytic action produced by stray currents.

It is certain that considerable assistance would be obtained if each time it were possible to say what was the cause of the damage from the exterior appearance of the corroded sheath. The result of the corrosion, either chemical or electrolytic, varies according to the nature of the material with which the sheath is in contact. When the lead remains exposed for some time to the action of the air or the soil, the products of the corrosion are usually a mixture of lead hydroxide and of lead carbonate similar to commercial white lead. When chemical salts such as chlorides, sulphates and nitrates are found in the neighbourhood of the sheath, the corresponding lead compound will result. These products may result from ordinary corrosion or electrolytic corrosion. The study of the constitution of the products of corrosion does not give by itself a sufficiently precise indication to decide on the cause of the corrosion. There is, however, a lead compound of which the presence in the products of corrosion enables it to be stated that the origin is electrolysis due to stray currents. This is lead di-oxide (PbO_2). The reddish-brown colour of this compound and its chemical actions are characteristic ; it is thus easy to determine its presence, even when it only exists in very small quantities. Nevertheless if it be true that the presence of lead di-oxide can be considered as sufficient index of the electrolysis by stray currents, its absence in certain cases does not show that corrosion is not of electrolytic origin.

Electrolysis by stray currents does not necessarily give rise to the formation of di-oxide ; and, once formed, this compound is easily decomposed by the contact of organic reducing compound ; the electric current which has formed this oxide can, when reversed, destroy it completely.

It is useful to analyse the residue taken from the corroded lead sheaths with a view to determining whether or not they contain peroxide. One of the reagents used for this purpose is formed of a diluted solution of 5 per cent. or more of tetramethyldiaminodiphenylmethane in a 50 per cent. solution of acetic acid.

The salts deposited in the attacked sheath are allowed to fall on a white plate containing a little of the reagents ; if clear blue layers are formed in the mass of the liquid, it is an indication that the salts contain lead di-oxide. In the case where only very small traces of lead di-oxide exist it is necessary to wait 10 to 20 seconds before the precipitate is formed.

It is to be noted that certain other oxidisable materials, including the copper compounds, produce the same reaction ; but in the case of corrosion to cable sheaths these compounds are not likely to be present.

In Germany, another method is used for finding the cause of corrosion. It consists of a comparison between the quantities of lead chloride existing in the products of corrosion and the proportion of the salt existing in the earth in the neighbourhood of the points attacked. If the products of corrosion contain a greater proportion of lead chlorides than the proportion contained in the earth, it is assumed that this corrosion should be attributed to the passage of an electric current.

PART 4.

CONSTITUTION OF TELEPHONE CABLE SHEATH

Recommendation No. 1.

Impurities in the Constituents of Cable Sheath.

The International Telephone Consultative Committee—

Considering :—

That the number of alloys used at the present time for making cable sheath is large and that the source of supply of the metals used in the various countries for this purpose, differs.

That strictly speaking the various impurities present do not modify to the same extent the mechanical properties of all the alloys used.

That sufficient details as to the effects of the various impurities met with, are not available.

Recommends :—

That it does not appear worth while to insert, in the specification for the supply of telephone cable, a clause concerning the permissible quantity of impurities among the normal constituents.

That it appears preferable to specify certain requirements which cable sheaths must fulfil.

Recommendation No. 2.

Elasticity of Cable Sheaths.

The International Telephone Consultative Committee—

Considering :—

That the elasticity of cable sheaths and in general their various chemical properties, depend upon their chemical composition and their construction.

That at the present time there exists a large variety of alloys, having various degrees of elasticity.

That, depending upon the placing and method of installing the cable, it may be considered advantageous that certain qualities should preponderate.

That supervision of the manufacture and tests during the acceptance of the cable appear to guarantee that the sheath will have the proper qualities of the alloy called for in the specification.

Recommends :—

That the constitution of the alloy or alloys to be used should be laid down in the specification, the choice being made so that the cable should be suitable for the use to which it is to be put.

That it is advisable to check that the method of manufacture ensures that the metal is submitted to an appropriate and regular thermic treatment, avoiding the formation on the sheath of weak longitudinal sections.

That it is also advisable to check during acceptance that on the one hand throughout the length of the sheath the amount of the constituents is as specified, and on the other hand that all sections of the sheath are of homogeneous composition and construction.

PART II.

CHANGES AND ADDITIONS TO THE SECTION OF THE ENGLISH EDITION, 1934, ENTITLED "QUESTIONS OF TRANSMISSION AND MAINTENANCE."

PAGE 172.

Under the section entitled "Distortion" make the following changes in paragraph

"(1) **Frequency Distortion** (of a transmission system)." Omit the reference in brackets ("see Part 2 . . .") at the end of the second paragraph.

Substitute the following for paragraph "(2) Phase Distortion."

Phase Distortion (Distorsion de phase, Phasenverzerrung, delay distortion) of a transmission system is caused by the fact that the derivative of the phase shift with respect to angular velocity in the system with specified terminal conditions is not constant for all frequencies transmitted. Both in the case of commercial telephone circuits and of special broadcast circuits phase distortion is characterised by (1) The difference between the time of propagation at 800 p:s and the time of propagation at the minimum frequency effectively transmitted by the circuit and (2) The difference between the time of propagation at 800 p:s and the time of propagation at the maximum frequency effectively transmitted by the circuit.

In the United States of America a frequency of 1000 p:s is used as a reference frequency for phase distortion on all circuits.

Note.—The above expression, "time of propagation," is the derivative of the phase shift of the circuit with respect to the angular velocity w for the frequency considered ($w = 2\pi f$). This time of propagation is the time taken to traverse the whole length of the circuit by the envelope of a group of two sinusoidal waves of very close angular velocities w and $w+d\,w$.

PAGE 173.

Add Note (1) as follows to "Transmission Level Diagrams":—

(1) Transmission level diagrams of international circuits are established by taking as origin, the origin of the circuit in terminal service.

PAGE 175.

At the end of the two paragraphs under "Signal to Noise Ratio" insert the following:—

NOTE

To define the signal voltage a distribution curve is used based on the following considerations:—

The signal voltage has an instantaneous amplitude which varies as a function of time and cannot be defined completely by a single numerical value.

To get a complete picture a start must be made with a curve of the envelope of the signal voltage. Figure 1 below shows that the signal voltage is composed of separate impulses of various amplitudes and duration.

This can be shown as a distribution curve.

To do this a sufficiently long interval of τ milliseconds is divided into very small portions of τ milliseconds duration and for the amplitude of the envelope, the mean amplitude during the duration τ is taken. This value A is included between the value $A = 0$ and the maximum value Am in the time interval τ. If the different values of amplitude A are taken in increasing orders of magnitude, they can be shown by a distribution curve (see Figure 2). This curve, for instance, shows that 100 per cent. of the values fall below the value Am or that 50 per cent. of the values fall below the mean value A.

This curve shows completely, in the time interval τ, the signal voltage existing in that interval.

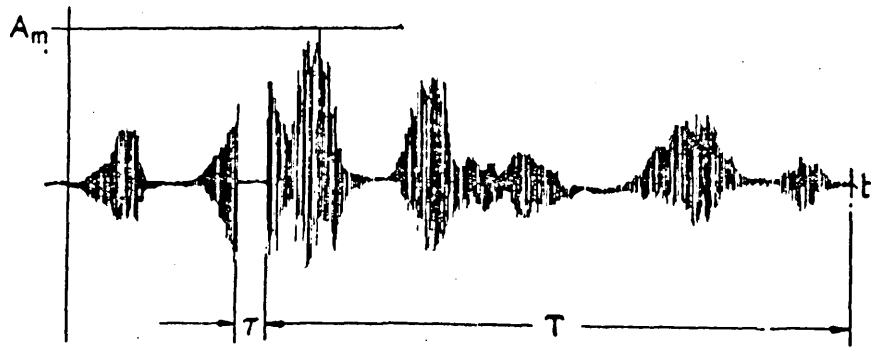


FIG. 1.

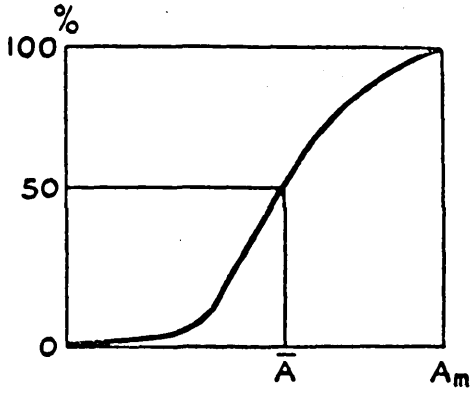


FIG. 2.

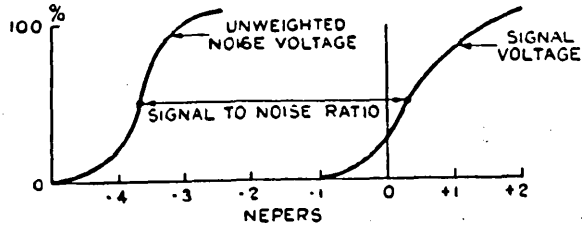


FIG. 3.

In making such a curve an oscillogram corresponding to the time interval τ may be taken and used as indicated above.

Another method consists in using in place of the oscillograph a recording voltmeter which records without distortion the envelope of the signal voltage. In place of a continuous recording the following method may also be used. An indicating apparatus is connected to the line for a sufficiently short time and the deviation A is observed during the time interval τ (see Figure 1). This measurement is repeated many times and thus a large number of isolated readings are obtained which can be shown as a distribution curve (see Figure 2). When a sufficient number of measurements has been made the same result is obtained as is given by a continuous recording. The method of discontinuous readings gives the more correct results the smaller the time interval τ The integrating period of the indicating apparatus should not be longer than the period τ.

For the measurement of the noise voltage it is necessary to discriminate between a weighted voltage (psophometric voltage) and an unweighted voltage (Fremdspannung). Distribution curves are plotted both for the weighted and unweighted voltages, in the manner described above (by inserting in front of the indicating apparatus a filter for the measurement of psophometric voltage). Figure 3 illustrates distribution curves of the noise voltage and also of the signal voltage; in this figure the voltages are shown as absolute levels. With such a representation the signal to noise ratio can be read.

The selection of τ depends upon the object of the distribution curves. If it is a question of determining the amplitude of voice signals the use of a volume indicator having an integration period of 200 milliseconds is recommended. If it is a question of determining the maximum power that a system (such as a broadcast circuit) can transmit without appreciable non-linear distortion, it is advisable to use a peak indicator with an integration period in the order of 20 milliseconds. In some cases it may be beneficial to use both instruments simultaneously.

PAGE 184.

Change sub-title " General Telephone Switching Plan " to <u>*General European Toll Plan.*</u>

Change paragraph " (4) " to read as follows :—

(4) That pending the formulation of the future General European Toll Plan, the Administrations and Operating Companies take cognizance of the " Provisional Guiding Principles for establishing a General European Toll Plan " quoted below and make use of the essential C.C.I.F. recommendations on transmission and maintenance which are incorporated in those " Guiding Principles."

Omit section headed " List of essential C.C.I.F. recommendations on transmission matters . . ." including sub-items up to and including " Interconnection of four-wire circuits (p. 236).

After paragraph " (5) " item " (c) " add :—

Provisional Guiding Principles for the establishment of a General European Toll Plan.

A mixed committee including representatives both from the operating and the technical services was appointed by the Plenary Meeting at Copenhagen in 1936 to prepare the above.

Questionnaires were prepared for distribution to the various Administrations and Operating Companies in order to obtain from the various countries the information required for this study in a comparable form.

While awaiting the result of the work of this Mixed Committee the C.C.I.F. recommends Administrations and Operating Companies to take into account the following Provisional Guiding Principles when fixing the normal, auxiliary, or emergency routes for international telephone relations.

Provisional Guiding Principles: It now appears possible to admit that, in the near future the international type of communication will consist of not more than two international circuits, that is,

that there will not be more than one switching point (transit exchange) between the two terminal international exchanges ; in any case this is an ideal towards which it is necessary to trend. At the same time it appears that it will be possible to arrange that in practically all cases each national transmitting or receiving system will not be composed of more than two toll circuits.

The set up shown in Figure 1, therefore, may be considered as representing a typical international communication.

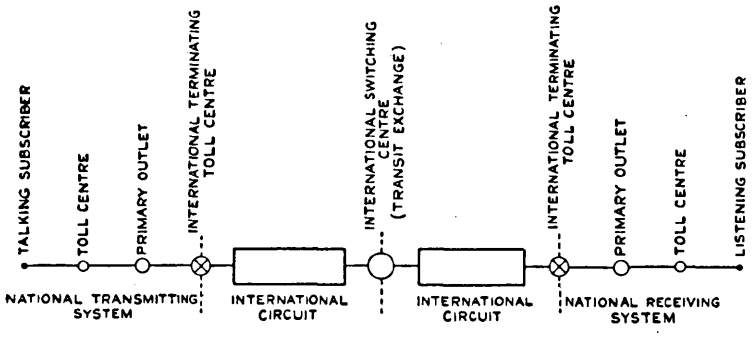


FIG. 1.

International telephone circuits (as well as the national toll circuits, the exchanges, the local network, and the subscribers' instruments in the national transmitting and receiving systems) must be installed and maintained so that the essential recommendations of the C.C.I.F. as regards transmission are satisfied in the international European telephone service.

These essential recommendations are as follows :—

Practical limits for the total reference equivalent of an international communication between two subscribers (p. 197, English Edition 1934).

Practical limits for the reference equivalent of the national transmitting and national receiving systems of an international communication between two subscribers (p. 198, English Edition 1934).

Practical limits for the overall equivalent of an international telephone circuit (p. 227, English Edition 1934).

Frequency band effectively transmitted and frequency distortion of two-wire, four-wire and carrier current circuits (open wire and cable) (pp. 200 and 227 English Edition 1934).

Relative levels (p. 228, English Edition 1934).

Stability (p. 232, English Edition 1934).

Echo-effects (p. 231, English Edition 1934).

Propagation time (p. 232, English Edition 1934).

Transient phenomena in ordinary telephone circuits (p. 233, English Edition 1934).

Crosstalk and other disturbances (p. 233, English Edition 1934).

Inter-connection of four-wire circuits (p. 236, English Edition 1934).

In accordance with the recommendation of the C.C.I.F. entitled " General conditions which international circuits, used for ordinary telephony, must fulfil " (p. 226, English Edition 1934), international telephone circuits must be four-wire circuits.

In the essential recommendations mentioned above it is specified that the time of propagation on each national transmitting or receiving system shall not exceed 50 milliseconds, that the time of propagation on international circuits shall not exceed 150 milliseconds and that the time of propaga-

tion on the land link between a subscriber and the terminal of the inter-continental radio telephone circuit shall not exceed 100 milliseconds.

Without in any way changing these figures which are maximum values, values of 50 milliseconds for each of the national transmitting and receiving systems and of 100 milliseconds for the combined two international circuits included in a typical transit international communication, will be used in drawing up a general European toll plan.

Determination of the minimum equivalent at which an international circuit or a national toll circuit can be operated must be carried out as detailed in the recommendation entitled " General conditions which international circuits, used for ordinary telephony, must fulfil " (see later " Calculation of the minimum equivalent admissible in service ").

For each international circuit it is necessary to give consideration to an " effective transmission equivalent " (see later) which is calculated by taking into account :—

(1) The minimum value of overall equivalent admissible in service from the point of view of echo.

(2) Transmission impairment due to the limitation of the band of frequencies effectively transmitted by the circuit, or to line noise.

PAGE 185

Substitute the following for the existing text under the heading, " Criterion of the quality of transmission in international telephone service."

The International Telephone Consultative Committee—

Unanimously recommends :—

(1) That the criterion to be used in evaluating the transmission in the international telephone service should be based on actual results obtained in service.

(2) That there is a need now for a method to be evolved for measuring transmission quantitatively which would give results in conformity with those observed under service conditions.

PAGE 187.

In the section entitled " Effective Transmission Equivalent," substitute for " Note 2 " and " Note 3 " the following :—

Note 2.—It is recommended for the planning of future international circuits that the indications given in Note 1 below, " Impairment in quality or transmission due either to line noise or to restriction in the frequency band effectively transmitted," be taken into account.

Note 3.—The present state of the question of effective transmission equivalents in the United States, Great Britain, Germany and Rumania is outlined in Note 2 below (p. 91 of this volume).

and add :—

Note 4.—Tests carried out in Germany, Great Britain, and the United States have shown that the effect of room noise on telephone transmission can be evaluated as an increase in the reference equivalent of the complete system. In practice, however, it is difficult to determine the quantitative effect of room noise on the quality of telephone transmission. Laboratory tests using room noise reproduced by a gramophone although useful, only indicate approximately the impairment due to room noise on actual telephone conversations on account of the differences in speaking and listening when room noise is or is not present. Note 3 below (p. 230), " Effect of room noise on the quality of telephone transmission," summarises the present state of this question which must continue to be studied until the essential characteristics of a " reference system for effective transmission " have been decided.

PAGES 187-193.

Substitute the following for " Note I " contained on pp. 187-193 (1934 *edition*) :—

NOTE I.

IMPAIRMENT IN TRANSMISSION QUALITY DUE EITHER TO LINE NOISE OR TO RESTRICTION IN THE FREQUENCY BAND EFFECTIVELY TRANSMITTED OVER THE CIRCUIT.

1. Impairment in transmission quality due to the restriction of the frequency band effectively transmitted over the long-distance circuit.

Tests carried out by the SFERT Laboratory in 1935 relative to the impairment in transmission quality due to the restriction of the frequency band effectively transmitted over the long-distance circuit have shown that the curve (Fig. 1*) can be used in Europe to evaluate the impairment in transmission quality so caused. Although this curve was drawn up some years ago in the United States of America by means of articulation tests using solid back microphones, it has been verified that it also holds good when repetition tests are made under service conditions using the combined handset type of apparatus.

The curve (Fig. 1) is for the case when there is present a room noise of average intensity (50 db above 10^{-16} watts per sq. cm. at 1 000 p : s) at the receiving end. It is applicable for the usual values of reference equivalent (specified by the C.C.I.F.).

2. Impairment in transmission quality due to line noise.

Noise in a telephone connection, appearing in the receiver of a subscriber's instrument interferes with the ease with which the subscribers converse. An important part of this noise when long-distance connections are involved may arise in the toll circuits. In this case it is desirable to be able to evaluate the impairing effect of the toll circuit noise alone, assuming, however, that this toll circuit noise will be present, in practice, in a complete connection which may also contain a certain amount of noise arising from the local circuits and equipment. Furthermore, when considering this effect, account should be taken of the fact that this toll circuit noise is subject to attentuation and distortion in passing from the toll circuit terminals to the subscriber's receiver. It is also essential that the effects of room noise at the receiving end be considered.

Articulation tests carried out at the SFERT Laboratory have shown that the table below can be provisionally used in Europe for evaluating the impairment in transmission quality in a complete telephone connection from subscriber to subscriber, which is due to the presence on this connection of various amounts of noise produced on the toll circuit and corresponds to a psophometric electromotive force measured, with the psophometer specified by the C.C.I.F., in the toll exchange at the end of the toll circuit which is closed by a 600 ohms pure resistance, using a suitable ratio transformer.

Psophometric electromotive force (measured in accordance with the C.C.I.F. recommendations) millivolts.	Impairment in Transmission Quality due to Line Noise. decibels.
<2.5	0
2.5 to 4.0	1
4.0 to 5.5	2
5.5 to 7.0	3
7.0 to 8.5	4
>8.5	5

This table is applicable to telephone transmission systems of which the total reference equivalent reaches the maximum limit of 40 decibels recommended by the C.C.I.F. This is the most interesting

* See p. 187, English Edition, 1934.

case to be considered so far as the effect of induced noise is concerned, being a case where a circuit in cable is extended by an open wire circuit which is exposed to induction from near-by electric power lines, and over which the total reference equivalent of the telephone communication is, generally speaking, high.

In the values of impairment in the quality of transmission due to line noise, shown in the table (1) the effects of a small quantity of noise in the local lines of a large town have been included and (2) the existence has been admitted at the receiving end of the telephone communication, of an average room noises of 50 decibels above 10^{-16} watt at 1 000 p : s.

3. The use in practice of the curve and table giving the impairment in quality of transmission due to line noise or to the restriction of the frequency band effectively transmitted.

The curve given in Fig. 1 above entitled " Impairment in the quality of transmission due to the restriction of the frequency band effectively transmitted (average room noise) " and the table giving the " Impairment in the quality of transmission due to line noise " must be used as indicated below, as has been done for many years in the United States of America.

(*a*) Impairment in the quality of transmission due to the restriction of the frequency band effectively transmitted.

The curve showing the impairment in the quality of transmission due to the restriction of the frequency band effectively transmitted by a toll circuit is based on certain typical conditions of the termination of the circuit, the line noise present, etc. This curve shows under these conditions, the additional attenuation required to be inserted in the so-called " reference " toll circuit, which has very little distortion, in order that the quality of transmission observed (repetition rate) may be the same as that observed on the toll circuit in question. It is assumed for instance that the intermediate lines (between the toll exchange and the subscriber's exchange) are loaded with 88 millihenry coils at approximately 2 700 metres spacing, and thus have a cut-off of approximately 2 900 p : s. The reference circuit (with which the transmission on the toll circuit was compared) consisted of a distortionless line equipped with a low pass filter (250–3 000 p : s) having a sharp cut-off at the two extremes of the band. At the receiving end an average room noise (50 db above 10^{-16} watt per square centimetre at 1000 p : s) is admitted and also a line noise due to the exchanges and the toll circuit equipment corresponding to a psophometric reading at the terminals of the telephone receiver of 17 db above the reference noise (reference noise = 10^{-12} watt at 1 000 p : s).

Under operating conditions in practice a toll circuit may be used, of course, in the establishment of various sorts of telephone communications having different amounts of room noise at the receiving end, different toll circuit extensions and different toll terminal losses (mean of the reference equivalents of the local transmitting and receiving systems). For instance a certain toll circuit may be connected in one telephone communication to two intermediate lines having a low cut-off and in another telephone communication to two short intermediate lines having a high cut-off. Such variations in conditions show that there is no need to follow precise and exact methods, such as are used in a laboratory, in making practical use of the curve giving the impairment in the quality of transmission due to the restriction of the frequency band effectively transmitted. In the Bell System, therefore, it is customary to use, in place of an exact curve, a series of 1 decibel steps in the practical application of the theory of impairment in the quality of transmission due to attenuation distortion (restriction of the frequency band). On the other hand, these 1 decibel steps are used in a conservative manner ; for instance, for any value on the curve between 0 and 0.9 db., the same number (zero db) is used.

In order to lessen the work of engineers responsible for the planning of circuits and their subsequent establishment it has been found convenient to use the values (in db), as shown in the Appendix below, for the impairment in the quality of transmission due to the restriction of the frequency band for various lengths of the different types of toll circuit usually met with. It has been found that this can

be done with sufficient accuracy from a study of the average transmission characteristics at various frequencies for varying lengths of different types of circuit. This avoids the necessity of calculating exactly the overall attenuation of a toll circuit or of measuring the same at various frequencies, before giving to it a value of " impairment in the quality of transmission due to the restriction in the frequency band." This impairment is given for each circuit on the toll circuit record lay-out card.

When two circuits having different characteristics are permanently connected to form a toll circuit the impairment in the quality of transmission due to the restriction in the band of frequencies for the combination can, of course, be obtained by measuring the equivalent-frequency characteristic of the whole circuit, by noting the maximum frequency effectively transmitted by the circuit (that is, the frequency at which the overall attenuation exceeds by 10 db the equivalent at 1 000 p : s) and by reading the corresponding ordinate on the curve showing the impairment in the quality of transmission due to the restriction of the frequency band effectively transmitted. In practice it is not always possible to make measurements at various frequencies of the overall attenuation of each built-up toll circuit which is why the Bell System uses a method of approximation to obtain the desired result. This approximation consists in combining in accordance with the quadratic law (square root of the sum of the squares) the decibels read as ordinates on the curve for each section of the circuit. Suppose, for instance, that a toll circuit is made up of a circuit having a low frequency cut-off (2 000 p : s say) and a circuit having a high frequency cut-off (2 800 p : s say), the latter obviously having little effect on the attenuation distortion of the combined circuit. The impairment in the quality of transmission as read on the curve for a maximum frequency effectively transmitted of 2 800 p : s is nearly 0.8 db, whereas it is about 4.1 db for a maximum frequency effectively transmitted of 2 000 p : s. The addition of these two numbers in accordance with the quadratic law gives approximately 4.2 db.

Sometimes, however, measurements of overall attenuation at various frequencies are made to determine more precisely the attenuation distortion (and the impairment in the quality of transmission resulting therefrom) in the case of built-up toll circuits presenting very irregular or unusual conditions.

When a circuit is used for transit service it must obviously be satisfactory from the point of view of echo, crosstalk, and singing point, and at the same time, it must not unduly increase the effective transmission equivalent of the whole built-up telephone connection. In transit service (that is, when the two complementary circuits at the two ends are excluded) the majority of toll circuits used for transit traffic must not, in the present Bell System practice, add more than 2 to 4 decibels to the effective transmission equivalent of the whole communication circuit. If the type of toll circuit which it is proposed to use for a certain communication shows an impairment in the quality of transmission due to the restriction of the frequency band effectively transmitted greater than zero decibel, the value of this impairment must be subtracted from the desired value of effective transmission equivalent in order to obtain the overall attenuation at 1 000 p : s at which the toll circuit must be operated for transit service. It is this value of overall attenuation at 1 000 p : s which must be considered to determine if this particular type of toll circuit will be satisfactory from the point of view of echo, crosstalk and singing point. For instance, assume that it is desired to use a physical circuit loaded with 172 millihenry coils at 1 830 metre spacing and having an effective transmission equivalent of 4 decibels. Since this type of toll circuit is considered to give an impairment of 1 decibel in the quality of transmission due to the restriction of the frequency band effectively transmitted, it will be necessary to limit the length of this toll circuit to such a number of kilometres that the circuit may be operated with an overall attenuation (at 1 000 p : s in transit service) equal to $4 - 1 = 3$ decibels. Thus the sum of the overall attenuation at 1 000 p : s in transit service (3 decibels) and of the impairment in transmission quality due to the restriction of the frequency band effectively transmitted (1 decibel) gives the desired value of effective transmission equivalent (4 decibels).

It is admitted that the above method includes a certain amount of approximation in the case

where a long circuit is built up by means of several toll circuits each contributing an impairment in transmission quality due to the restriction of the frequency band effectively transmitted. Take, for instance, five circuits interconnected, each of an overall attenuation at 1 000 p : s of 3 decibels, and each giving an impairment in transmission quality due to the restriction of the frequency band of 1 decibel. The overall attenuation at 1 000 p : s of the circuit obtained from these five sections would be 15 decibels, and the total effective transmission equivalent of this combination, obtained by adding together the effective transmission equivalents of the five individual sections, would be 20 decibels. On the other hand, by calculating this total effective transmission equivalent by adding together according to the quadratic law the five impairments (each equal to 1 decibel) a resultant value would be obtained of :—

$$15 + \sqrt{1^2 + 1^2 + 1^2 + 1^2 + 1^2} = 15 + \sqrt{5} = 17.2 \text{ decibels.}$$

This practice, nevertheless, is not productive of any harmful effect for the following reasons :—

(1) The great majority of circuits used in transit service, especially circuits joining provincial transit centres to regional transit centres, or interconnecting regional transit centres, are of high quality (impairment in the quality of transmission due to attenuation distortion equal to zero.) The likelihood is, therefore, very small of having in a long telephone communication, more than one or two circuits which give an impairment in transmission quality due to the restriction of the frequency band effectively transmitted. If there are not more than one or two such circuits involved in a transit communication the above method of combining the impairments following the quadratic law, is reasonably accurate.

(2) The effect of the above approximation in the case of a communication over several interconnected circuits is to obtain a transmission slightly better than would be indicated by the simple addition of the individual effective transmission equivalents of each of the component circuits. This approximation, therefore, errs in the right direction since it results in a better grade of service than is indicated by the simple addition of the effective transmission equivalents.

(*b*) Impairment in Transmission Quality due to Line Noise.

The table given above shows the impairment in transmission quality in a toll circuit due to the presence of a certain amount of line noise, an amount determined by a reading obtained on the psophometer conforming to the C.C.I.F. recommendations connected across the end of the toll circuit. This impairment in transmission quality is the additional attenuation which must be inserted in the (silent) reference circuit so that the same results (from the telephone service point of view) may be obtained in both cases. Generally speaking the practice in regard to impairment in the quality of transmission due to line noise is similar to that employed for impairment in transmission quality due to the restriction in the frequency band effectively transmitted that is, steps of 1 decibel are used. Since ordinarily it is impossible to predict the amount of noise which will occur on a given circuit before that circuit has been established, a measurement with the psophometer is first made of the noise on existing lines and a value in decibels is given to the circuit for impairment in transmission quality due to line noise, which corresponds to the table given above.

In the United States of America line noise is measured with a psophometer called an " American Noise Meter," shunted across the end of the toll circuit terminated by 600 ohms (the impedance of the toll circuit is always brought up to 600 ohms by suitable transformers). This psophometer is equipped with a network A (conforming to the weighting table of the C.C.I.F.), followed by a network B (simulating the distortion of typical lines and apparatus met with in the Bell System connected between the toll circuit terminals and the listening subscriber's receiver). Also, in the United States of America psophometric readings are expressed in decibels in relation to the reference noise of 10^{-12} watt at 1 000 p : s. From the table given below a value for noise rating (1st column) and a value of noise transmission impairment (2nd column) are obtainable for a toll circuit on which a certain quantity of line noise (3rd column) has been measured.

Noise Rating	Noise Transmission Impairment in Decibels.	Circuit noise measured at the end of the toll circuit using the American Noise Meter with its filters A + B. Noise is expressed in decibels above the reference noise (10^{-12} watt at 1 000 p : s).
N.0	0	0—29
N.1	1	29—32
N.2	2	32—35
N.3	3	35—38
N.4	4	38—40
N.5	5	40—42
N.6	6	42—43
N.7	7	> 43

Psophometric readings which fall on the limits of the step scale correspond to the noise rating next below. For instance, a reading of 29 decibels on the psophometer corresponds to noise rating N.0, 32 decibels to noise rating N.1, etc. As an example of the use of this table a psophometric reading of 33 decibels obtained at the end of a toll circuit would give this circuit a noise rating of N.2 and a noise transmission impairment of 2 decibels.

In the United States of America when a toll circuit has just been established psophometric measurements are made at each end, the larger of the two readings so obtained is used to determine the noise rating for the circuit. In order to facilitate the work of the maintenance and the technical services the noise rating and the noise transmission impairment are entered on the toll circuit record lay-out card. (This toll circuit record lay-out card shows the number of the cable pair used, or the numbers of the insulator pins carrying the open wires, the lengths of the repeater sections, the type and gain of each repeater, the potentiometer settings, etc. ; in short, all characteristics of the circuit which are of importance to the engineering and maintenance services.)

When two toll circuits of different type are permanently connected to one another the noise on the complete circuit so formed is measured on a psophometer and the noise rating (see the table above) for this whole circuit is directly obtained in preference to its being calculated.

It is often desirable, however, to calculate the noise transmission impairment for a connection made up of two or more toll circuits and in the Bell System the method used for calculating the resultant noise consists essentially of the following : (1) In referring to one particular point (say the end of the toll connection) the various noise components existing on the various individual circuits making up the connection, and then (2) in adding in accordance with the quadratic law (square root of the sum of the squares) the voltages corresponding to these various noise components referred to the same point.

Take, for example, two circuits AB and BC, each having an overall attenuation of 9 decibels, which are connected by a cord circuit repeater giving a gain of 6 db. Assume that 34 decibels are measured on the American Noise Meter at B, at the end of circuit AB considered alone, and that 34 decibels are measured on this noise meter at C, the end of the circuit BC considered alone.

First of all it is necessary to refer to point C (end of the combined connection) the 34 decibels measured at B on the end of the circuit AB, and to do this the gain of the cord circuit repeater (+ 6 db) at B, and the attenuation (– 9 db) of the circuit BC must be taken into consideration. The noise of the circuit AB referred to C is therefore $34 + 6 - 9 = 31$ decibels.

It remains to add, at point C and according to the quadratic law the two noise components 34 decibels and 31 decibels (American Noise Meter Scale). The zero of the American noise meter scale corresponds to 1 micro-micro watt at 1 000 p : s into a pure resistance of 600 ohms (a psophometric voltage of 0.0245 millivolt at 1 000 p : s).

On the other hand 34 db and 31 db correspond to a voltage ratio of 50.12 and 35.49 respectively.

The two psophometric voltages (expressed in millivolts at 1 000 p : s) to be added quadratically are therefore :—

$$50.12 \times 0.0245 = 1.2279 \text{ millivolt.}$$

$$35.49 \times 0.0245 = 0.8695 \text{ millivolt.}$$

The resultant psophometric voltage will therefore be :—

$$\sqrt{1.2279^2 + 0.8695^2} = \sqrt{1.508 + 0.756} = \sqrt{2.264} = 1.504 \text{ millivolt at 1 000 p : s.}$$

This corresponds to a reading of 35.76 decibels on the American noise meter since we have :—

$$\frac{1.504}{0.0245} = 61.41 \text{ and } 20 \log_{10} 61.41 = 35.76 \text{ decibels.}$$

Consequently, the two line noises of 34 decibels, each measured at the ends of circuits AB and BC, considered alone, give a resultant noise of 35.76 decibels at the end of the connection AB + BC(*). The table gives for such resultant noise of 35.76 decibels a noise transmission impairment of 3 decibels to add to the overall attenuation at 1 000 p : s of the connection made up of a combination of the two toll circuits.

In consequence of the custom of assigning nominal gains to various repeaters it has generally been found that it is impracticable to take count of noise by subtracting the noise transmission impairment from the overall attenuation of the circuit (as has been indicated above for the impairment in the quality of transmission due to restriction of the frequency band effectively transmitted). The reason is that the signal to noise ratio is, in general, independent of the overall attenuation ; in other words, an improvement in the overall attenuation of a circuit would tend to increase the noise transmission impairment of this circuit and that would compensate largely for the reduction in value of the overall attenuation.

In Europe, where line noise is measured by means of the psophometer specified by the C.C.I.F. (network A only) and shunted by a resistance of 600 ohms terminating the toll circuit (through a suitable transformer if necessary), it is recommended that in order to evaluate noise transmission impairment the procedure followed should be similar to that used in the United States of America and described above, but using the table in paragraph (2) above which gives the noise transmission impairment in decibels as a function of the noise EMF measured in accordance with the recommendations of the C.C.I.F. (in millivolts).

(c) Combination of an impairment in transmission quality due to the restriction in the frequency band effectively transmitted and a noise transmission impairment.

The methods described above constitute the practice followed in the United States of America to determine noise transmission impairment or impairment in the quality of transmission due to the restriction in the frequency band effectively transmitted, both for a single toll circuit and for a connection consisting of a combination of several toll circuits. To obtain the total transmission equivalent of such simple or complex circuits the usual practice consists in adding directly (1) the overall attenuation at 1 000 p : s, (2) the impairment in transmission quality due to the restriction of the frequency band effectively transmitted determined as indicated above, and (3) the noise transmission impairment determined as is indicated above.

---

* In practice the Bell System use curves which give directly the results of such an addition according to the quadratic law.

Length in miles (1 mile = 1 609 metres) of various types of circuit which corresponds to different values of transmission impairment due to the restriction of the frequency band effectively transmitted.

(Lengths that can normally be used with zero to 1 decibel more attenuation than the transmission impairment indicates.)

Type of Circuit	Transmission impairment due to the restriction of the frequency band (in decibels)			
	0	1 db	2 db	3 db
Two-Wire Circuits in Cable :				
0.9 mm diam. wires. Physical cct. loading 172 mH. Phantom cct. loading 63 mH. Spacing 1830 metres.				
Physical circuit	—	< 75 miles	75–200 miles	> 200 miles
Phantom circuit	< 150 miles	> 150 miles	—	—
0.9 mm diam. wires[1] Physical cct. loading 88 mH. Phantom cct. loading 50 mH. Spacing 1830 m or 915 m.				
Physical circuit	} any length	—	—	—
Phantom circuit				
1.3 mm diam. wires. Physical cct. loading 44 mH. Phantom cct. loading 25 mH. Spacing 1830 metres				
Physical circuit	< 300 miles	> 300 miles	—	—
Phantom circuit	< 300 miles	> 300 miles	—	—
Four-Wire Circuits in Cable :				
0.9 mm diam. wires. Physical cct. loading 44 mH. Phantom cct. loading 25 mH. Spacing 1830 metres				
Physical circuit	{ any length	—	—	—
Phantom circuit				
Circuits in non-loaded open wire :				
4.2 mm diam. wires (0.165 in.)	< 500 miles	> 500 miles	—	—
3.2 mm diam. wires (0.128 in.)	< 500 miles	> 500 miles	—	—
2.5 mm diam. wires (0.104 in.)	< 500 miles	> 500 miles	—	—
Carrier Circuits :				
Type A	—	—	—	any length
Type B	—	—	any length	—
Type C[2]	} any length	—	—	—
Type D		—	—	—

[1] Estimated for filters (in repeaters) having a high cut-off frequency. With such filters circuits of 1.3 mm. diam. wires (with loading H-44/25) would naturally have the same transmission impairment.

[2] For two systems type C in series without distortion a one decibel impairment may be allowed.

PAGE 194.

Change the title of " Note 2 " to read as follows :—

NOTE 2.

The Present State of the Question of Effective Transmission Equivalents in the United States of America, Great Britain, Germany and Rumania.(*)

and add footnote to page 194 *:—*

(*) See the Appendix following this Note 2, " Programme of tests which will be made in 1937 and 1938 by the SFERT laboratory on the subject of the conception of " effective transmission equivalent."

PAGE 195

Substitute the following for the text under " B. Great Britain,"

B. Great Britain

Since 1930 the British Post Office has carried out two series of experiments relative to the conception of effective transmission equivalent.

The first series of tests at Denman Street had for its object the perfection of testing methods to be used in solving this problem.

The second series of tests at Dollis Hill has been made or is being made on 35 different combinations of the various factors which affect transmission : line noise, room noise, frequency band effectively transmitted, reference equivalent, type of subscribers' line and apparatus, side tone, variations in battery supply, etc.

Tests have already been carried out on :—

The effect of subscriber's line resistance.

The effect of toll circuit attenuation.

The effect of line noise.

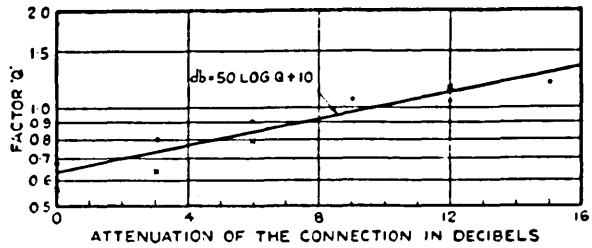


FIG. 1.

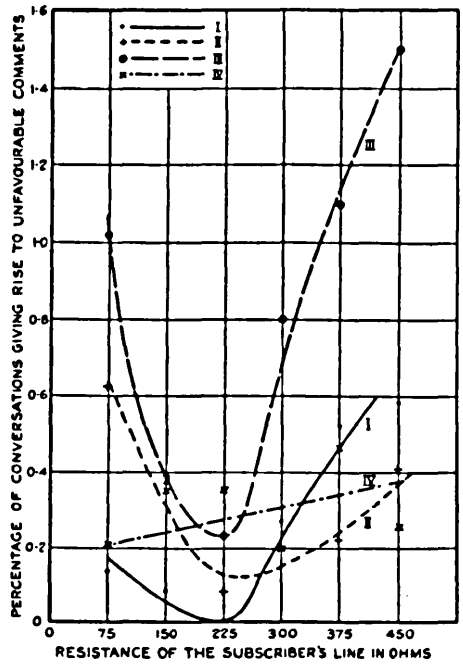


FIG. 2.

The last of these tests being only tentative it is not yet possible to publish the results obtained.

Results obtained on the two first tests are shown graphically on Figs. 1 and 2 as relative values in decibels in relation to a reference point corresponding in each case to the nominal value in service of the factor, the effect of which on transmission quality is being investigated.

With reference to the effect of subscriber's line resistance, the British tests show that, if repetition rates are used for the test, the effect of varying this resistance within the limits normally found in service was considerably less than was indicated by telephonometric tests previously carried out using volume only.

Fig. 1 shows the first results obtained in the investigation of the effect of toll circuit attenuation,

the relative values corresponding to the repetition rate observed with various values of attenuation of the toll circuit being plotted as ordinates under the name " Factor Q."

During the course of the repetition rate observations, a record was made of all unfavourable criticisms as to the transmission quality.

On Fig. 2 the resistances of the subscribers' lines in ohms are shown as abscissae while factors representing the relative values of unfavourable comments are shown as ordinates.

Curve I represents the normal British combined handset, Curve II the American combined handset, Curve III the British combined handset but using a toll circuit with an attenuation greater than 3 to 4 decibels and Curve IV the British anti-sidetone handset.

It should be noted that Curves I, II and III show a well defined minimum for a subscriber's line resistance of about 225 ohms. It appears that below this value (a short subscriber's loop) room noise becomes troublesome, and that above this value (a long subscriber's loop) the reduction in the transmitter current becomes troublesome.

PAGES 196, 197.

Substitute the following for the text under the heading " C. Germany."

C. Germany.

The German Telephone Administration in 1935 and 1936 carried out two series of tests in connection with effective transmission equivalent.

In the first series of tests the following were investigated :—

The effect of toll circuit attenuation.

The effect of line noise.

The results of these tests are shown by the curves in Figs. 3 and 4 as relative values with regard to the reference point which in each case corresponds to the nominal value in service of the factor, the effect of which on transmission quality is being studied.

In the second series of tests three kinds of apparatus, A, B and C, have been used successively, the receiving and transmitting reference equivalents of which are shown in nepers in the following table. The results obtained are shown in Figs. 5 and 6.

Apparatus	Reference Equivalent.	
	Transmitting	Receiving
A	+ 0.4	+ 0.3
B	+ 1.5	+ 0.1
C	− 0.2	+ 0.2

Concurrently with these tests the German Telephone Administration has made articulation tests with esperanto logatoms pronounced separately with the object of checking the conception of effective transmission equivalent. In collaboration with Messrs. Siemens & Halske, two " provisional working standards of effective transmission " had previously been constructed which were identical from the point of view of the apparatus, filters, line noise, room noise, adjustable artificial lines, etc., used. (See document C.C.I.F. 1935-1936 Transmission Document No. 22, pp. 84 to 91.) With the aid of this " provisional working standard of effective transmission " tests have been made to verify if the reduction in articulation, due to the simultaneous change in value of two factors, translated into a corresponding value of variation in the effective transmission equivalent, is equal to the sum of the transmission impairments measured when each factor was measured separately. This condition

would be fulfilled if the curves giving the relation between articulation and reference equivalent for various well-defined disturbing conditions (such as different values of room noise, different values of psophometric E.M.F.s due to line noise, etc.) were parallel, that is, if effective transmission equivalent and reference equivalent were independent.

The results of the measurements are shown graphically in Fig. 7. If comparison is made between the various curves it will be seen that sometimes their slopes are widely different, the parallel condition mentioned above only being obtained in the variation of certain factors, and then only over a certain range.

It is for this reason that the German Telephone Administration has proposed to undertake tests (especially at the SFERT laboratory) to determine over what range of variation of the different factors affecting transmission quality the transmission impairment due to each of these factors considered alone may be added algebraically in order to obtain the value of transmission impairment due to the combined effect of these factors acting simultaneously. (See the appendix at the end of the next section.)

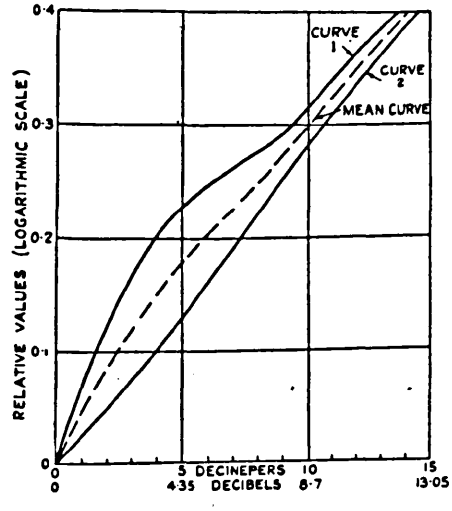


FIG. 3.

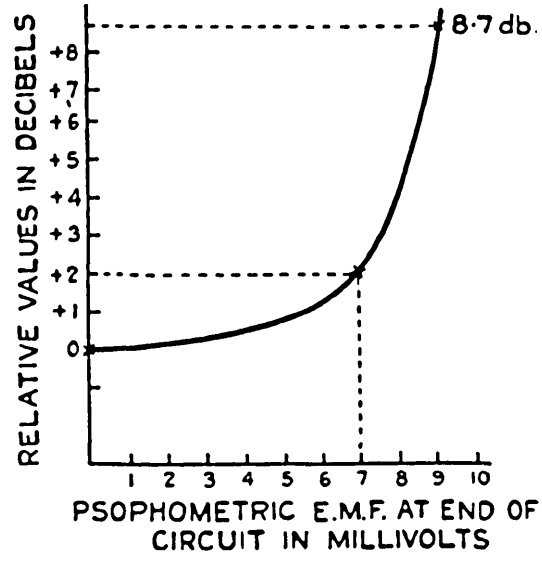


FIG. 4.

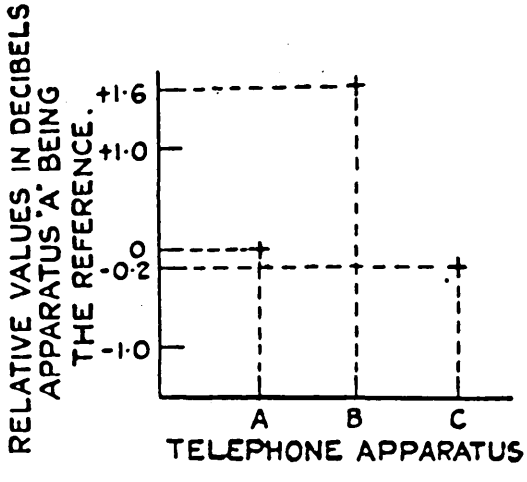


FIG. 5.

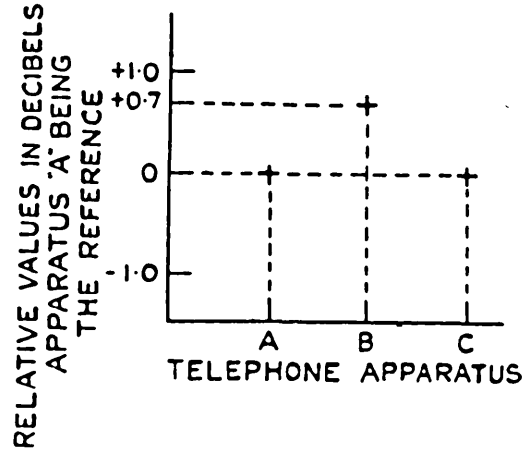


FIG. 6.

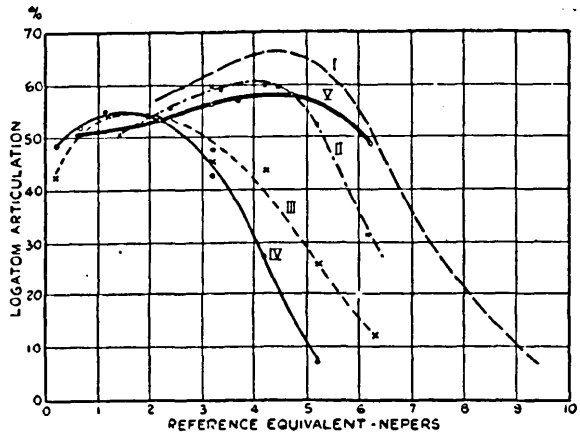


FIG. 7.

And add,

D. Rumania.

The Societatea Anonima Romana de Telefoane, considering that articulation (for instance, articulation over the speech band) when considered as a criterion of quantitative appreciation of telephone transmission quality has the disadvantage of not taking into account the fact that the subscriber helps in the good operation of a telephone system by speaking more or less loudly as circumstances require (since he has a natural tendency to force his voice when it appears necessary to do so), has proposed that appreciation of transmission quality should be based on "effective articulation," which is defined as follows :—

Effective articulation is that obtained on a telephone system when the articulation is measured with the volume which is used in service *on that particular system* and for all the particular conditions involved.

That necessitates a new study which is in two parts: (*a*) Determination of the mean value and of the variation of volume under service conditions, and (*b*) The modifications to be made in the so-called constant volume method of measurement of articulation to obtain values of effective articulation.

The work carried out in this regard by the Societatea Anonima Romana de Telefoane (and also by the Compania Telefonica Nacional de Espana) consists in the measurement of volume at Bucharest and Madrid under various circuit conditions, the existing room noise being considered each time. In addition, supplementary tests are in hand in the laboratory to determine the effect of side tone, line noise, reference equivalent of the system, etc., upon the speech volume of the person speaking at the origin of the circuit.

An essential condition of a practical method of appreciation of transmission quality is that it must be possible to divide the effective transmission equivalent into separate parts so that each part may be studied separately from the point of view of its economical contribution to the transmission quality of the whole system. On the other hand, it appears illogical to talk of transmission impairment as regards one part of the telephone system since generally it is only the attenuation components (the old method of specification by volume only) which are directly additive. For instance, the attenuation distortions in the various parts of a system may nullify one another so that no definite value can be given to any one of these distortions as regards its effect on the transmission impairment without considering the whole system.

In consequence, any practical method of appreciation of transmission quality must have additive

characteristics up to a certain point. This is so in the method based on articulation for the speech band. In fact, the calculation of articulation for the band of any system is made by adding the articulation for the band of any part of the system and for each part of the frequency spectrum.

The quality of transmission in any telephone communication is determined according to the new method of appreciation proposed by the Societatea Anonima Romana de Telefoane when the voice volume of the speaker is known and also the overall attenuation, from the air in front of the microphone to the air in front of the receiver, for each frequency or for each elementary band of frequencies. But the calculation of this attenuation from air to air for a large number of very narrow elementary bands of frequencies would lead to an excessive amount of work for the setting up of circuits and therefore it has been proposed to simplify this method by splitting up the frequency spectrum covered by the human voice into five bands only. Provisionally the following five bands have been selected :—

200 to 750 p : s
750 to 1 000 p : s
1 000 to 1 500 p : s
1 500 to 2 000 p : s
2 000 to 3 000 p : s

In each of these portions of the spectrum use is made of the average value of performance loss (l'affaiblissement en service) which is defined as follows :—

When a telephone circuit is set up, it is convenient to divide a telephone communication into three parts : (*a*) the local transmitting system, (*b*) the whole of the intermediate lines and toll circuits involved which is called " the line," and (*c*) the local receiving system.

In order to take into account all the factors affecting transmission quality it must be remembered that each part of the system may (*a*) have an effect on the speech volume emitted by the talker and (*b*) introduce an attenuation or a gain in each portion of the frequency spectrum mentioned above.

For instance, a toll circuit introduces attenuations in various portions of the spectrum, and if one of these attenuations should be large, the subscriber will raise his voice instinctively, that is, he will increase his speech volume so that the performance loss of this toll circuit would be less than its theoretical loss.

In a subscriber's telephone set an attenuation of speech current is produced inside the housing of the microphone at the transmitting end as well as some reaction on the speech volume emitted, due to side-tone ; at the receiving end there is a loss due to the receiver housing as well as a masking effect, due to noise.

The above examples indicate what is meant by performance loss. In planning a telephone network, the performance loss in each of the five portions of the frequencies mentioned above is considered separately, and for each portion of the spectrum the performance losses for each component part of the communication must be added together ; the results obtained for each portion of the spectrum must be added together in order to express quantitatively the transmission quality of the communication.

The foregoing is a very simple method of obtaining the fundamental data required for the establishment of plans of telephone transmission, that is, the performance loss of a subscriber's line of a certain gauge and length in each portion of the frequency spectrum mentioned above, or the performance loss of a toll circuit of a specified type and length (with different values of line noise) for each portion of the frequency spectrum mentioned above, etc. . .

The above considerations form only a brief summary of the study being made. La Societatea Anonima Romana de Telefoane will present additional details when the results of this study are ready for publication.

In particular, this Company will shortly advise the Secretariat of the C.C.I.F. as to the results of volume measurements made in Rumania (and also in Spain) in accordance with the methods referred to above.

Also add the following :—

Appendix.

Programme of the tests to be made at the SFERT laboratory on the subject of effective transmission equivalent.

The XIth Plenary Meeting of the C.C.I.F. has decided that the SFERT laboratory should carry out articulation tests with a view to deciding :—

Between what limits and under what conditions of transmission the conception of effective transmission equivalent is applicable.

To answer this fundamental question, the following investigations should be made :—

1. Effect of Room Noise.

Articulation tests will be made with three different values of room noise at the transmitting and receiving ends the mean value being defined by the number of phons x (measurement on the scale of the German sound meter) which corresponds to the room noise used in the SFERT laboratory (room noise 45 decibels above the average threshold of audibility of the operators of the SFERT laboratory). The two other values of room noise used will be 20 decibels above and below this average noise respectively.

The articulation tests will therefore be made with three different values of room noise :—

$$x - 20,\ x, \text{ and } x + 20 \text{ phons.}$$

for three different values of reference equivalent of side tone, viz. :—

0.4, 0.8 and 2 nepers.

Eventually, to reach the lowest of the above values of reference equivalent of side tone, it may be necessary to insert a transformer and an amplifier of suitable gain between the telephone set and the microphone (fed by a special local battery).

Also a test without any room noise may be made if the noise of $x - 20$ phons mentioned above still produces appreciable effects.

In tests made to determine the effect of any one factor it is desirable that all other test conditions should be kept constant ; consequently, it is desirable not only that the total reference equivalent of the various types of subscribers' telephones tested should be the same, but also that the side tone of these sets should be kept constant under all conditions.

As, however, it is difficult to keep the characteristics of side tone as a function of frequency the same for various types of subscribers' sets, it is thought that a sufficiently good approximation will be obtained if the reference equivalent of side tone is made equal for the different subscribers' sets.

It should be noted that the side tone effect due to room noise may differ considerably from the side tone effect of the voice. Since in articulation tests it is mainly the side tone due to room noise which has to be taken into consideration, it is the latter which should be measured and made uniform for all subscriber sets.

For this purpose the Administrations concerned are asked to indicate how the side tone of their individual subscribers' sets may be adjusted to one or several values to be determined, when they are connected to their battery supply circuit with a 300 ohm line (see Schematic 1, p. 100).

The reference equivalent of side tone for room noise will be fixed at a value of 0.8 neper for all the above-mentioned tests where it is essential to maintain constant side tone.

The desired variation of side tone could be obtained by adjusting the microphone current of the subscriber's set at the receiving end.

2. Effect of Line Noise.

The tests will be made with five values of psophometric E.M.F. : 0, 2, 4, 8 and 16 millivolts.

3. Effect of the Restriction of the Frequency Band Effectively Transmitted. (Band-pass filters 300-1 900, 300-2 000, and high pass filter 300 p : s.)

4. Summation of the Effects of the Various Factors.

(*a*) Room noise of x – 20 phons and band-pass filter 300-1 900 p : s.

(*b*) Room noise of x + 20 phons and band-pass filter 300-1 900 p : s.

(*c*) Room noise of x – 20 phons, band-pass filter 300-1 900 p : s, and line noise of 16 millivolts.

The tests must be made with commercial type subscribers' sets such as are normally in service in Germany, France, Great Britain, Sweden and the United States of America (Bell System). The general arrangement used for the tests will be as shown in Schematic 1, the line noise being introduced by means of a transformer placed between the band-pass filter and the transformer (ratio $2 = \sqrt{4/1}$) which precedes the receiving arrangement of 4 telephones listening simultaneously.

Although this arrangement necessitates on the receiving side 4 amplifiers, 4 artificial lines and 4 battery supply circuits, it is advisable to use it because the 4 apparatus used simultaneously for listening are electrically separated from one another so that the side tone of each is adjusted separately.

For line noise use will be made of the complex current of a small six-phase rectifier, not having resonant circuits, and built up as follows :—

(*a*) A Scott transformer fed from the 2-phase circuit of the SFERT laboratory and producing 6-phase current.

(*b*) A six phase copper-oxide rectifier, with no resonant circuit ending through a transformer and a triode valve in a potentiometer designed to provide across a resistance of some 10 ohms an alternating voltage varying from 0 to about 100 millivolts (see Schematic 2).

The sub-appendix below (p. 102) gives information as to the wave form of this six-phase rectifier.

The SFERT artificial line used in these tests will have an attenuation equal to or above 1.5 neper ; it will serve to adjust the total reference equivalent of the system to the desired value, that is, 30 decibels in the first part of the 5th series of tests and 40 decibels in the second part (see later). If necessary a distortionless amplifier will be inserted between the source of line noise and the transformer of ratio $\sqrt{4}$ (its input and output impedances will be of 600 ohms).

The average test conditions which characterise the specification of the telephone system shown on Schematic 1 will be as follows :—

1. Line Noise. Psophometric E.M.F. of 4 millivolts measured at the terminals of a 600 ohms resistance replacing the ratio $\sqrt{4}$ transformer.

2. Room noise : x phons.

3. Band-pass filter : 300-2 400 p : s.

4. Reference equivalent of side tone for room noise : 0.8 neper.

5. Transmission system reference equivalent : (*a*) 30 decibels, (*b*) 40 decibels.

In studying the effect of the different factors it is necessary to refer constantly to the average conditions given above varying only the factor in question, all other reference conditions remaining the same.

For the study of the different factors three methods are available : appreciation tests, repetition tests and articulation tests, all three of which are of great importance in characterising transmission quality. For studies in the SFERT laboratory only the articulation tests are capable of practical application.

To evaluate the variation of articulation in units of effective transmission equivalent it is necessary for each of the five types of apparatus to trace a curve of articulation as a function of the reference equivalent, all other conditions being those of reference. To take into account possible variations in the crew, articulation measurements will be made using the method of alternate tests, 50 logatoms being pronounced giving the desired value to the factor under study and then 50 logatoms under reference conditions, 50 logatoms being pronounced giving the desired value to the factor under study, etc. . . until 1500 logatoms for each condition have been pronounced.

In these alternate tests the various microphone capsules provided by any one Administration will be regularly interchanged in the handset used in transmitting, also the transmitter will be shaken each time after a small number of logatoms has been pronounced. Thus, systematic errors due to packing of carbon granules or to too great a difference between various microphone capsules of the same commercial type will be avoided.

Each time a commencement is made with one of the series of tests on any one of the telephone systems used, the crew will make preliminary articulation tests in order to get used to the tone of conversation over that particular system. It is only after an approximate value of articulation has been reached that the measurements proper are commenced.

The talking operator will maintain throughout the tests the " normal volume for telephonometric tests," which will be checked by means of a volume meter placed at the output of the transmitting system. This " normal volume " is 16 decibels below the reference volume, which corresponds to a power of 6 milliwatts into 600 ohms at 1 000 p : s. This " normal volume " will be measured from time to time by the Volume Indicator connected to the terminals of the SFERT distortionless transmitter. Since the crew of the SFERT are specialists who are well able to maintain the " normal speech volume," it will suffice if the talking operator (after pronouncing some 200 logatoms) measures his volume on the Volume Indicator of the SFERT Laboratory. Tests have shown that in using connected phrases for pronouncing the various logatoms a loss of time of some 50 per cent. would be entailed without affecting in any way the articulation values found by a specialised crew. The operating crew will also measure (about every fortnight) the articulation of the distortionless SFERT with the 1900 p : s low pass filter in order to check the crew and later to correct the articulation measurement results to take into account the practical experience of the crew (even though this 5th series of experiments is only concerned with alternate tests to determine differences of articulation).

The curve of variation of articulation as a function of the reference equivalent of each telephone system (made under reference conditions except for attenuation which varies) will be extended as far as necessary on the low values of overall attenuation (10 decibels) as well as on the high values of overall attenuation (60 to 70 decibels) in order that interpolation may never be necessary for determination of a transmission impairment due to any one factor (that is, for the determination of the increase in attenuation which would produce the same impairment as does this factor).

In order to make each of these articulation measurements in the presence of line noise, psophometric measurements will be made either by connecting the psophometer to the terminals of a 600 ohms resistance replacing in the schematic the $\sqrt{4}$ transformer or by connecting the psophometer (of high input impedance) to the terminals of the telephone receiver used by the listening operator (and later to the input terminals of the telephone set used by the listening operator). In the first case (measurement over 600 ohms) operations will be confined to taking the readings of the American psophometer

by noting the deviations obtained successively with the two combinations of filter networks (taking care to cut out of circuit the 600 ohms resistance mentioned above when the American psophometer has its input impedance equal to 600 ohms).

In the second case (measurement at the receiver terminals) the psophometer will be connected to one of the receivers used for listening.

If v is the reading of the psophometer in millivolts, the psophometric voltage V will be given by the formula :—

$$V = v \sqrt{\frac{600}{Z}}$$

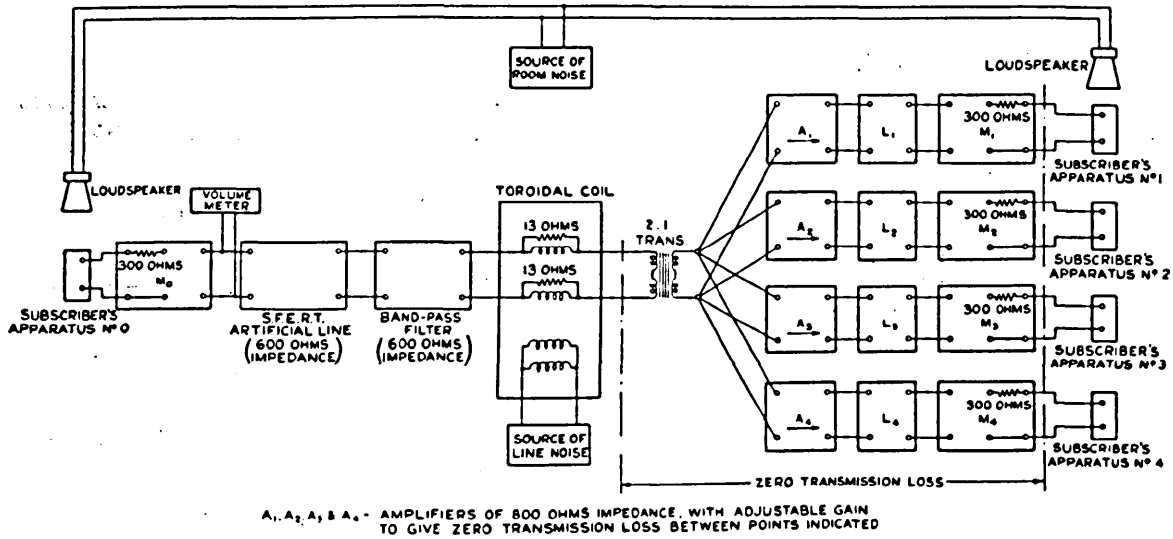
Z being the value in ohms of the impedance presented by the receiver at the principal resonant frequency when it is disconnected from its set and when it rests on a table face downwards, covered with felt of about 1 cm. in thickness.

In the room where the speaking takes place as well as in the listening cabinet, a constant room noise will be produced by a gramophone record of the type used by the British Post Office associated with a pick-up and small electrodynamic loudspeakers.

This room noise will be adjusted to one of the values mentioned above.

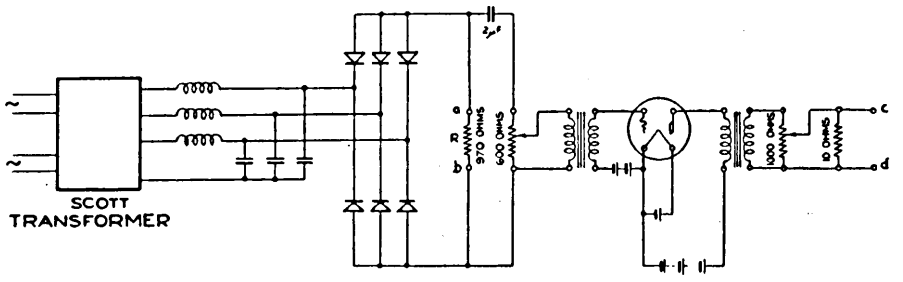
A measurement will be made each time an articulation test is carried out " in the absence of the line noise to be studied " (see above) of the value of the noise existing at the terminals of the receivers of the telephone apparatus used for these articulation tests. This measurement, made by connecting the psophometer to terminals of the receiver used for listening (in the absence of the line noise to be studied but in the presence of the room noise of x phons mentioned above), will determine for each telephone apparatus used in the tests the " reference condition from the point of view of the noise observed in the receiver of the listening operator."

Since considerable changes in the personnel of the SFERT crew (changing of the German and British operators and the arrival of a new Swedish operator) are envisaged, it will be necessary to correlate the results obtained by the present crew with those of the future crew. Such correlation will be obtained in particular by tests made by both crews on the telephone systems described above in their average conditions of test defined above.

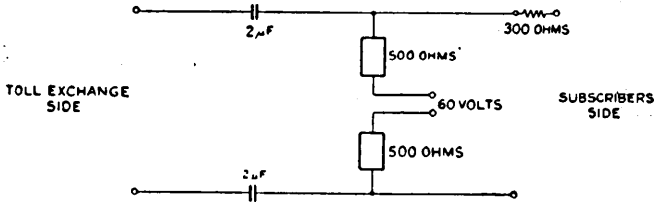


Schematic 1.

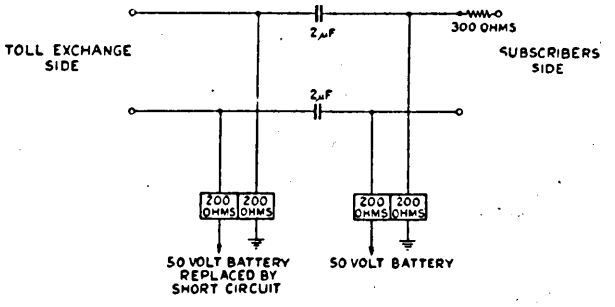
As a result of these tests, not only will it be possible to obtain information as to the field of application of the idea of transmission equivalent, but also to obtain statistical data as to the effect of the various factors affecting transmission. This is of much importance in connection with the drawing up of a General European Toll Plan.



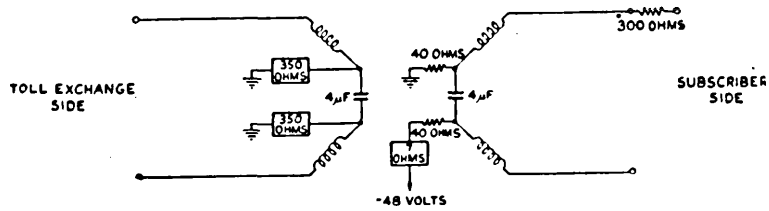
Schematic 2.



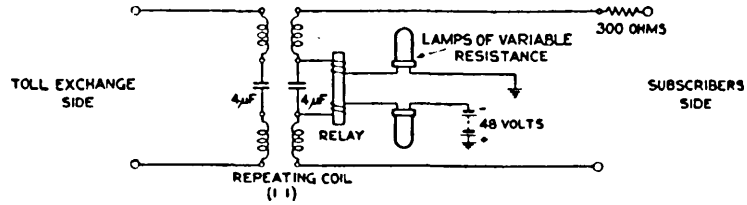
Schematic 3.



Schematic 4.



Schematic 5.



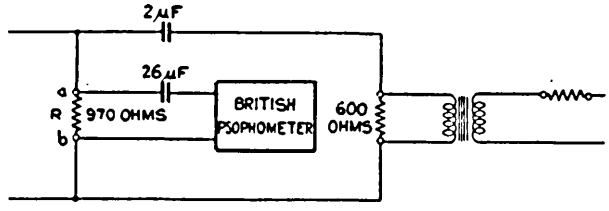
Schematic 6.

Sub-Appendix

Measurements made on the six-phase rectifier used in the SFERT laboratory.

In order to obtain information as to the telephone form factor of voltage of the six-phase rectifier used in the SFERT laboratory, the following measurements have been made :—

(*a*) Continuous current voltage at the terminals *a*, *b*, of the 970 ohms resistance *R* (see Schematic No. 2) = 27 volts.



Schematic A.

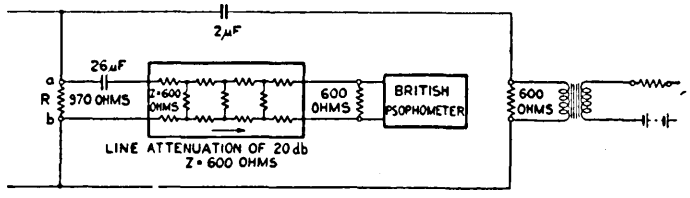
(Voltage measured with a voltmeter of 27 500 ohms internal resistance.)

(*b*) Weighted voltage at terminals *a*, *b* of the 970 ohms resistance *R*.

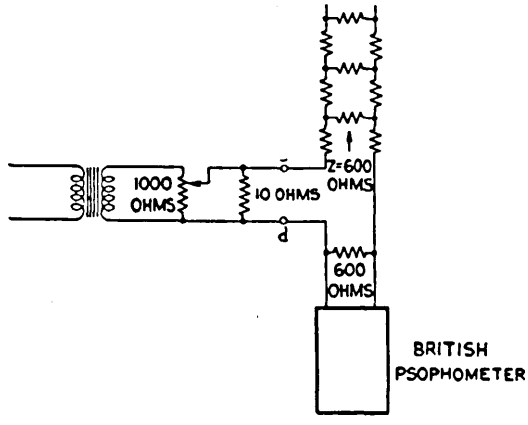
A measurement made with the British psophometer of high input impedance and a 26 μF condenser (Schematic A) has shown a weighted voltage about the highest reading, 110 millivolts, of the psophometer. The circuit was then arranged as in Schematic B and the psophometer reading was then 37.9 millivolts.

(*c*) Measurement of the weighted voltage at the output terminals *c*, *d* of the six-phase rectifier (Schematic No. 2) was then made with the British psophometer, having a high input

impedance and with the adjustable potentiometers at the maximum setting. The psophometric voltage so obtained was 81.4 millivolts.



Schematic B.

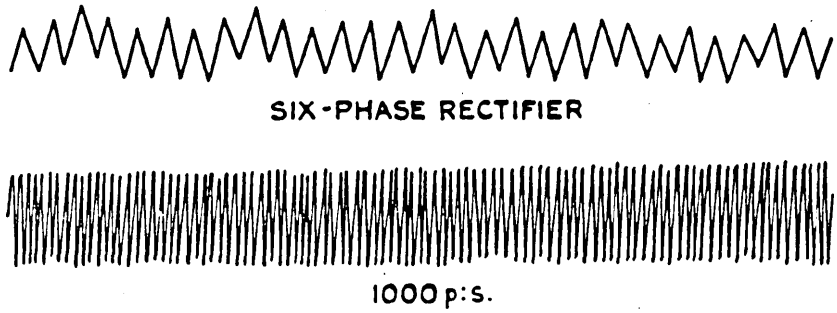


Schematic C.

(*d*) To represent conditions with the six-phase rectifier in service the weighted voltage was then ascertained with the British psophometer with the circuit arranged as shown in the Schematic C and with the potentiometers at the " maximum " setting ; the reading obtained was 35.75 millivolts.

Note.—In the arrangements as in paragraphs *c* and *d* above the adjustable potentiometers would, if desired, enable the voltage to be gradually decreased to zero.

(*e*) An oscillogram of the current produced by the six-phase rectifier has been obtained at the end of a cable circuit of the underground network of Paris which connected the rectifier in the SFERT laboratory to an oscillogram at the laboratory of the P.T.T. Service d'Etudes et de Recherches Techniques. This oscillogram is reproduced below.



and add the following:—

NOTE 3.

Effect of Room Noise on Telephone Transmission Quality.

The quantitative effect of room noise on the quality of telephone transmission has been determined both by articulation tests, particularly in Germany and Great Britain, and in the United States of America by repetition tests.

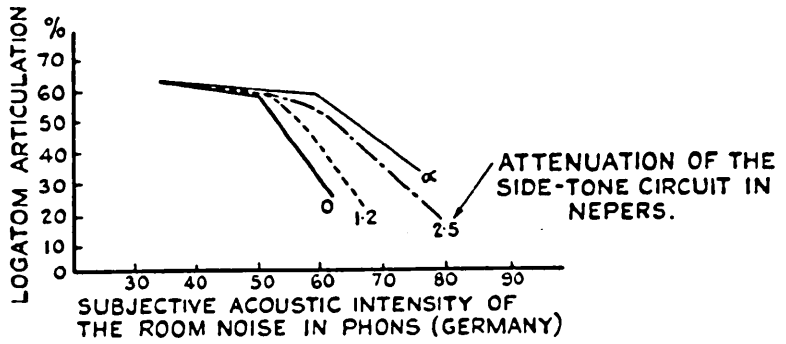


Fig. 1.

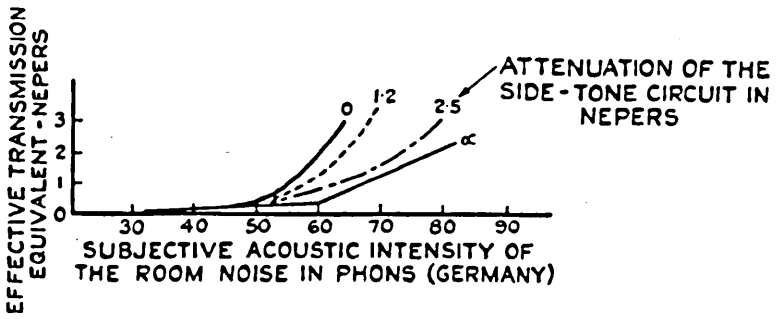


Fig. 2.

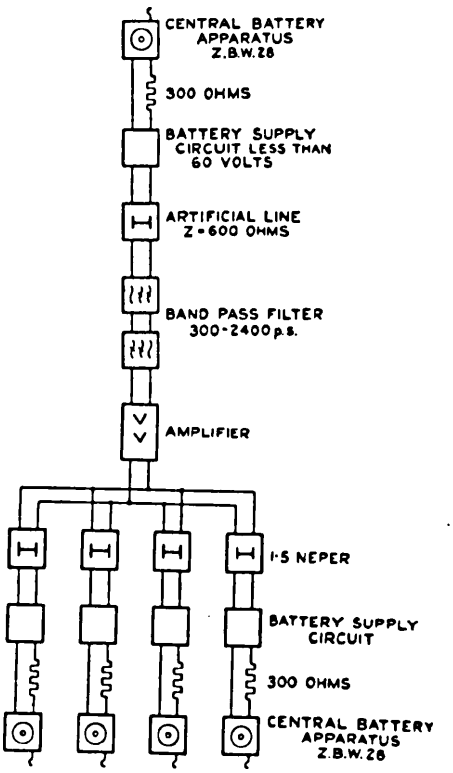


Fig. 3.

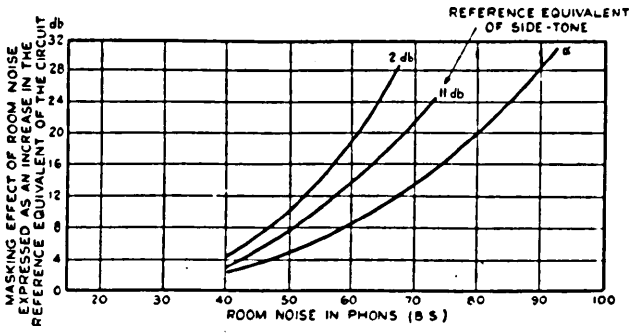


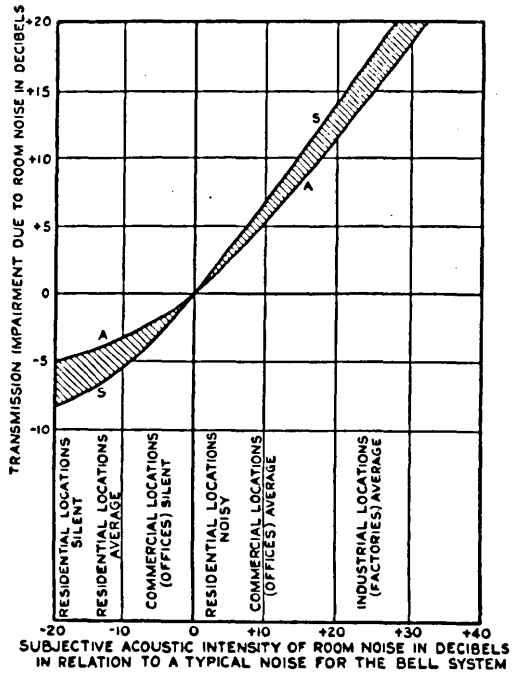
Fig. 4.

The curves in Figs. 1, 2 and 4 are representative. The curves in Figs. 1 and 2 were plotted in Germany with the circuit arrangement as shown in Fig. 3.

The normal value of reference equivalent of side tone of existing subscribers' sets corresponds to an attenuation of the side tone circuit of between 1 and 2 nepers.

APPENDIX 1.

AMERICAN TELEPHONE AND TELEGRAPH COMPANY.



Transmission impairment due to room noise at the receiving end.

Curve A : Reduced side tone due to anti-side tone circuit.

Curve S : Side tone with normal circuit and induction Coil No. 46.

PAGE 198.

Add footnote [1] *to the title as follows :—*

Practical Limits for the Total Reference Equivalent of the National Sending and Receiving Systems in an International Communication between Two Subscribers[1]

as given below :—

---

[1] When differences exist between results of measurements of the sending and receiving equivalents of subscribers' sets, obtained by direct comparison, and indirect comparison with the SFERT the only values which should be communicated to Administrations and Operating Companies are those obtained from the SFERT laboratory.

Since information as to the relative transmission qualities of the subscribers' apparatus in use in the different countries is necessary in preparing a general European toll plan it is recommended that a method of comparing these apparatus should be studied which takes into consideration as far as possible the idea of effective transmission equivalent.

For the moment the best method to use appears to be based on an articulation comparison of the different sets with the SFERT.

The establishment of a detailed method will necessitate a more profound study by the 4th C.R.

PAGE 201.

At the end of paragraph " (2) *" under the section on "* Propagation Time *" (beginning on p.* 200*) add the following note :—*

Note.—The time of propagation referred to above is the quotient of the length of the connection by the velocity of a permanent sinusoidal wave of 800 p : s (mean frequency of the human voice). The velocity is the quotient of the angular velocity by the wavelength constant of (or phase constant) of the connection.

For the section headed "Transient Phenomena" substitute the following :—

Transient Phenomena in Ordinary Telephony.

The International Telephone Consultative Committee—

Unanimously recommends :—

That the phase distortion of international circuits and of national toll circuits (including their equipment) should be such that the differences between propagation times do not exceed the following :—

Admissible difference between the propagation time at 800 p : s and the propagation time in the case of

	Minimum frequency effectively transmitted.	Maximum frequency effectively transmitted.
1. A Continental Communication :—		
On the intermediate section	10 milliseconds	5 milliseconds
On each of the national sections	20 milliseconds	10 milliseconds
On the whole communication	50 milliseconds	25 milliseconds
2. An Intercontinental Communication :—		
On the section between the subscriber and the origin of the intercontinental circuit.	30 milliseconds	15 milliseconds

Note.—The " propagation time " referred to above is the differentiation with respect to the angular velocity w of the out of the phase change (of the circuit or the combination of circuits) for the frequency f considered. (The angular velocity w is the product of the frequency f and 2π). This propagation time is the time taken to traverse the whole circuit (or combination of circuits) by the peak of the envelope of two sinusoidal waves of very close angular velocities w at $w + d\,w$.

PAGE 201.

Change sub-heading "Frequency of Signalling Currents" to :—

Signalling in International Telephone Service.

I. RINGING ON THE INTERNATIONAL CIRCUIT.

The International Telephone Consultative Committee—

etc., etc.

In the Note at the end of paragraph "(1)" omit the sentence in brackets.

PAGE 203.

Replace the section headed "Choice of a Single Frequency for Routine Measurements" by the following :

II. TRANSMISSION OF DIALLING IMPULSES OVER INTERNATIONAL CIRCUITS.

The International Telephone Consultative Committee—

Unanimously recommends :—

1. That it is advisable that the audible frequencies to be used in Europe for the transmission of dialling impulses should be fixed at 600 and 750 p : s.

2. That the system employed should not interfere with the operation of echo suppressors.

3. That the power at the input should be limited in the case of carrier systems.

III. VOICE FREQUENCY SIGNALLING IN AUTOMATIC TELEPHONE SERVICE.

The International Telephone Consultative Committee—

Considering :—

That it is desirable for the future to obtain automatic selection of subscribers by operators at a distant exchange, not only in the same country, but also in a foreign country (the ideal being that an operator could reach automatically any subscriber whatever).

That in toll telephone operation with long distance automatic selection the signals transmitted over the international circuits must be suited to the characteristics of toll telephone systems used.

That four main types of signalling exist in automatic telephony, viz :—

(1) Dialling tone (the warning that the selector switch is ready to receive dialling impulses).

(2) Ring back tone (to advise the operation of the called subscriber's ringer).

(3) Busy tone (to advise that the line of the called subscriber is busy).

(4) Number not available tone (to advise that it is not possible to reach the desired subscriber for some reason, the line being temporarily out of service, the number called is for the moment reserved), but it is not necessary to transmit this signal on international circuits.

Unanimously recommends :—

1. That, in Europe, it is advisable to standardise the automatic exchange signals liable to be transmitted over toll circuits in the future. These signals are the dialling tone, the ring back tone, the busy tone and the number unobtainable tone.

2. That for these signals it is advisable that a frequency between 400 and 450 p : s should be used to avoid interference with the ordinary ringing signals (500/20 p : s) or the transmission of dialling impulses (600 p : s and 750 p : s).

3. That continuous signals should be avoided as these block the echo suppressors, and that a suitable interruption period should be given to the 400 and 450 p : s frequencies to distinguish the various signals of dialling tone, ring back tone and busy tone.

Note.—Administrations and Operating Companies are asked to put these recommendations into force at once and to examine the question of the selection of the interruption period with a view to their common adoption by all countries.

PAGE 227.

Replace the section headed " (1) Terminal Equivalent " by the following :—

(1) **Terminal equivalent.** The equivalent (operative, transducer loss or insertion loss between 600 ohms pure resistance terminations) of an international circuit for terminal service, including the line transformers measured at 800 p : s should not exceed 1.3 neper or 11.3 decibels for a two-wire circuit and 1 neper or 8.7 decibels for a four-wire circuit.

It is desirable that the nominal value of equivalent for terminal traffic on an international circuit should never exceed :—

1.0 neper or 8.7 decibels for a two-wire circuit.
0.8 neper or 6.9 decibels for a four-wire circuit.

A variation of $\pm$ 0.2 neper or 1.7 decibel is allowed to take account of variations of the equivalent under service conditions.

Under these latter conditions the zone around each international terminal exchange (traffic terminal zone) which may be served by such circuits is defined as follows :—

(*a*) The reference equivalent of the national transmitting system for all subscribers should not exceed 1.95 neper (17 decibels).

(*b*) The reference equivalent of the national receiving system for all subscribers should not exceed 1.45 neper (12.5 decibels).

Under the same conditions it is desirable that in the future when new telephone networks are being planned or existing networks reconditioned efforts should be made so that for about 90 per cent. of the subscribers the reference equivalent of the national transmitting system does not exceed 1.6 neper (14 decibels) and that of the national receiving system does not exceed 1.1 neper (9.5 decibels).

The terminal traffic zone is generally limited by operating considerations, especially by the fact that usually only one circuit is used. Ordinarily the zone falls within a radius of 50 km with the international terminal exchange as a centre.

Note.—In the most unfavourable case when owing to accidental variations the terminal equivalent of the international circuit in service reaches the value of 1.0 + 0.2 = 1.2 neper, the reference equivalent between two subscribers is divided as follows :—

for 100 per cent. of the subscribers :— 1.95 + 1.2 + 1.45 = 4.6 nepers.
for 90 per cent. of the subscribers :— 1.6 + 1.2 + 1.1 = 3.9 nepers.

PAGE 227.

After the paragraph " (3) " and before the heading " Frequency Distortion " add the following section.

Calculation of the " Minimum Equivalent admissible " in service.

By admitting that the transit equivalent of each four-wire circuit portion of the international connection should be between 0 and 0.34 neper or 0 and 3 decibels, it may be considered that all risks of singing on international transit connections has been avoided.

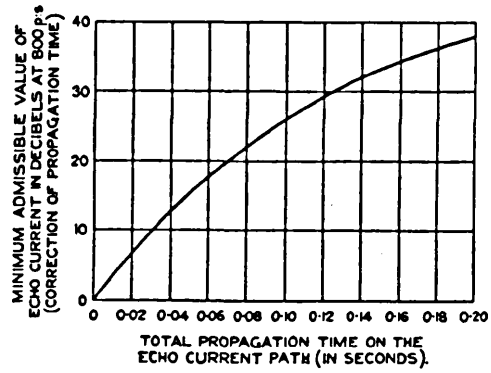


FIG. 1.—Delay weighting term for circuits without echo suppressors.

And, since it is unlikely that the same cause of crosstalk will act simultaneously on the three parts of the international connection (national transmitting system, international circuit, and national receiving system), it appears unnecessary at present to take crosstalk into account in fixing values of minimum equivalent for each toll circuit forming part of the international connection. This decision may, therefore, be confined to a consideration of talker echo.

The effects of echoes flowing back to the talker, from the standpoint of the minimum equivalent at which a toll circuit, or combination of toll circuits, can be operated, were determined at first by various appreciation tests made by telephone Administrations and Operating Companies. These tests showed that the serious nature of these effects increased with the time of propagation of the circuit or combination of circuits considered. Echo suppressors may be used on four-wire circuits to block echoes and thus considerably reduce their ill effects (see paragraph below, " Effects of Echoes ").

Following the tests mentioned above an agreement was arrived at for circuits without echo

suppressors as to the minimum admissible value for the attenuation of echo current for a given total time of propagation in the echo path. This curve is shown in Fig. 1 and is entitled " Delay weighting term for circuits without echo suppressors."

The Mixed Committee for the General European Toll Plan after the meeting at Copenhagen drew up a curve of the " delay weighting term " for circuits equipped with echo suppressors (sensitivity referred to zero level equal to 30 decibels) (see Fig. 2).

By means of these fundamental curves the minimum equivalent admissible, from the point of view of echo, for a toll circuit or a combination of toll circuits can be calculated. The method of calculating the minimum admissible equivalent from the point of view of echo for a two-wire circuit is given in Appendix 1 below (p. 117). The method of calculation for a four-wire circuit with or without an echo suppressor, and for a combination of two-wire and four-wire sections with echo suppressors on the latter is given in Appendix 2 below (p. 119).

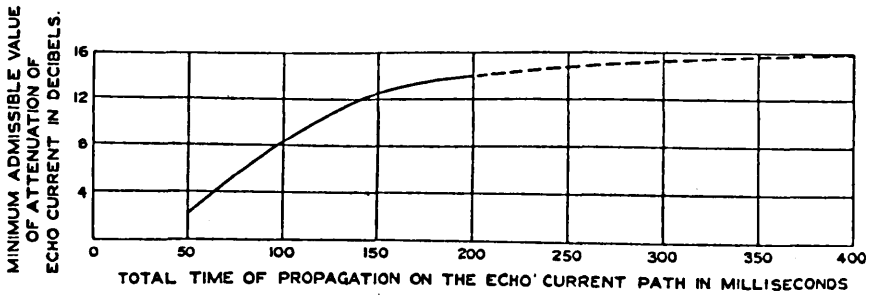


FIG. 2.—Showing the curve for delay weighting term time for circuits equipped with echo suppressors.

Note.—This curve was not printed in Vol I bis, but was published after the meeting in Paris of the Mixed Committee for the General European Toll Plan in September, 1937.

PAGE 228.

Substitute the following for the section headed " Relative Levels."

Relative Levels.

For convenience, the origin, in the determination of relative levels, has been taken as the end of the circuit at the sending office (toll test board at that office). A correction must be made to take account of the difference in impedance of the line at the two points at which the measurement is carried out. If at the point considered the value of the power, voltage or current, as the case may be, is greater than the corresponding value measured at the sending end, the level in this case is positive ($+ n$), if it is less the sign is negative ($- n$).

In the case of four-wire circuits, granted that the equivalent may vary with frequency within the limits specified above (Graph No. 2) it is agreed to adopt provisionally for this type of circuit and for the power levels at the output terminals of the repeaters in the frontier stations (towards the frontier) the limits obtained by taking for the nominal relative power level (800 p : s) the value of + 0.5 neper or + 4.3 decibels (Graph No. 3).

It appears unnecessary to fix tolerances for the variations with frequency of the level measured at the output of a frontier repeater since this figure is easily calculated from the tolerances admitted for the relative power level.

At any point on a four-wire circuit and for any frequency in the band effectively transmitted the relative power level should not exceed + 1.1 neper or + 9.5 decibels, nor be less than − 3.0 nepers or − 26 decibels. These maximum and minimum values apply when vacuum tubes are used

giving a maximum power output of about 50 to 60 milliwatts and where cables are concerned for which a psophometric E.M.F. of 5 millivolts is admitted at the end of the circuit. If vacuum tubes of a different power output are used the maximum relative level admissible on a four-wire circuit can be calculated as follows :—

Let N be the undistorted power which a valve with an internal resistance R_i and a plate voltage U_a can furnish. We then have :

$$N = U_a^2/50R_i$$

which agrees well with experimental results.

Let N_0 be the power of 6 mW at zero level. For the maximum relative level we then have :

$P_{max} = \frac{1}{2} \log_e N/N_0 = 2.3 \log_{10} U_a$ (volts) $- 1.15 \log_{10} R_i$ (Thousand ohms) $- 2.85$ .....(Formula 1)

Fig. 1 represents, graphically, the relation between P_{max} and R_i for $U_a = 220$ V and $U_a = 135$ V, respectively. The value of + 1.1 neper (+ 9.5 decibels) as a maximum relative level corresponds, for example, to $R_i = 20\,000$ ohms at $U_a = 220$ V.

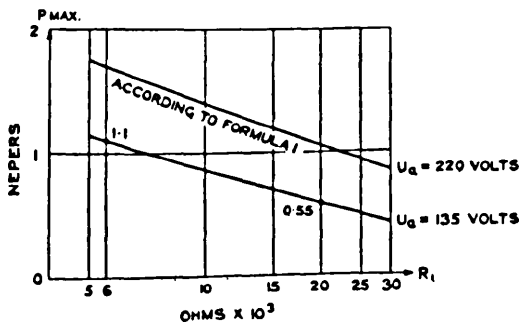


FIG. 1.

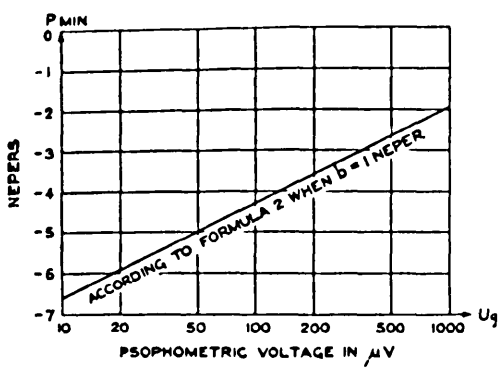
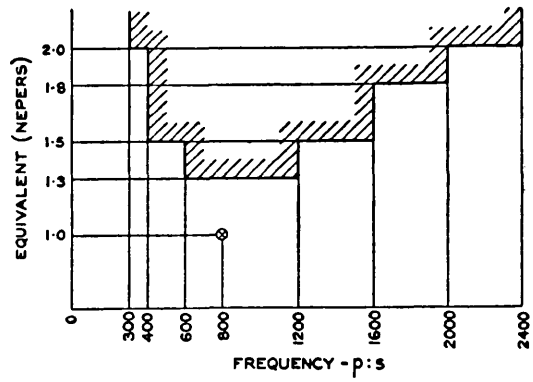


FIG. 2.

The minimum permissible value of the relative level at any point of the circuit is based on the condition that the permissible psophometric E.M.F. at the end of the circuit is 5 mV. If b is the equivalent of the circuit, it may be assumed that in that circuit the permissible minimum level at a point where the psophometric E.M.F. is 5 mV, is $-b$ nepers. Consequently, if $2U_g$ denotes the psophometric E.M.F. at any point, the minimum relative level at that point is :

$$P = -(b + \log_e 5\ (\text{mV})/2U_g) \quad \text{.....(Formula 2)}$$

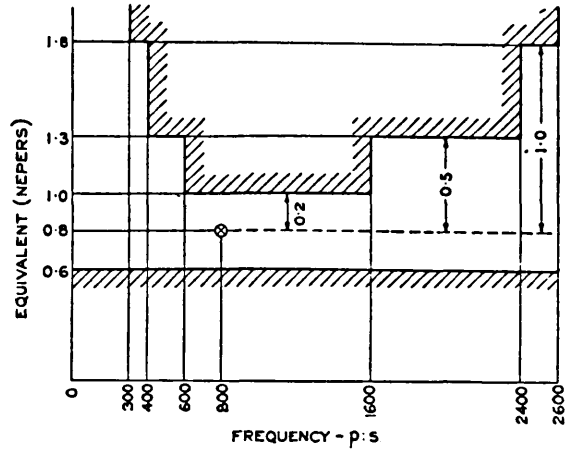
The permissible minimum value of the relative power level, therefore, depends on the extent to which the psophometric E.M.F. can be reduced by protective measures (see Fig. 2 which is valid for $b = 1$). It is advisable in designing a telephone circuit to allow a certain margin of safety between the calculated values of the maximum relative power levels and the minimum permissible.



GRAPH No. 1.

Limits of the equivalent of an international two-wire circuit.

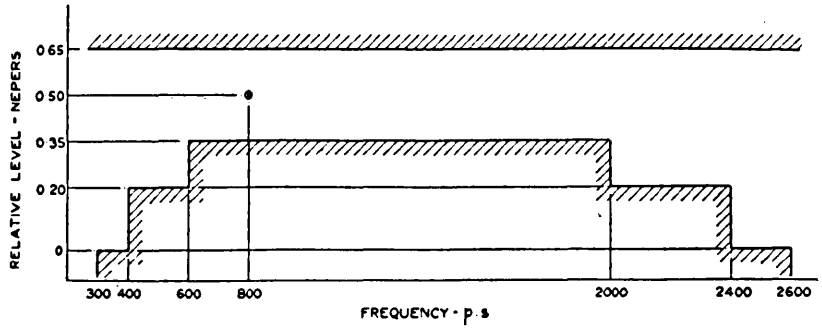
Note.—The curve of the equivalent in terms of frequency should lie in the unshaded area.



GRAPH No. 2.

Limits of the equivalent of an international four-wire circuit in terminal service at the extreme ends.

Note.—The curve of the equivalent in terms of frequency should lie in the shaded area.



GRAPH No. 3.

Limits of relative power levels at frontier stations of an international four-wire circuit.

All of the above applies to four-wire circuits. For two-wire circuits it is necessary to take into account the loss in the differential transformer (the value of which is about 0.5 neper or 4.8 decibels) and allow the same maximum power level as for four-wire circuits, deducting the above noted transformer loss.

The permissible minimum relative level for a two-wire circuit is not determined by the permissible psophometric E.M.F. but by the maximum gain of the repeaters, with due regard to the regularity of the circuit. In modern cables with high degrees of regularity and favourable crosstalk values, high gains may be allowed in two-wire repeaters and the same minimum relative power levels may be used as for four-wire circuits. (This assumes that the relative power level is measured at the input of one of the repeater elements in a two-wire circuit and not at the input of the repeater circuit, as a whole.)

PAGE 231.

Replace the section headed " <u>*Echo Effects*</u> *" by the following.*

Echo Effects.

Echo suppressors should always be provided on international circuits used for transit traffic.

It is recommended that, in the future, terminal echo-suppressors should be associated with four-wire international circuits in the three following cases.

1. When the circuit is used for automatic switching.
2. When the circuit is to be used simultaneously for ultra acoustic telegraphy.
3. When the circuit is used for carrier working.

Taking into account the definitions given below in the "Note on echo suppressors," it is provisionally recommended to consider hang-over time rather than "partial closing time" and to calculate also the optimum hang-over time of an echo suppressor.

The hang-over time consists of two parts :—

1. Two and one quarter times the time of propagation at 800 p : s on the cable between the echo suppressor and the far end of the four-wire circuit. The supplementary tolerance of the quarter takes into account the time of propagation across the repeaters and their associated equipment and also the fact that at other frequencies than 800 p : s the time of propagation figure may well be slightly higher.

2. A constant, the value of which is between 50 and 70 milliseconds to take care of the four-wire circuits not equipped with echo suppressors and the two-wire circuits of the national transmitting and receiving systems incorporated in the international circuit.

Limits for the partial closing time will be set after a study of the operation of echo suppressors has been made by various Administrations and Operating Companies.

It is advisable that the equivalents specified for international circuits and for toll circuits which form part of national transmitting and national receiving systems, should be such that the echo effects do not become troublesome (see the Note above, "Calculation of the minimum equivalent admissible in service").

To prevent faulty operation of echo suppressors due to noise it is advisable :—

(1) To limit the sensitivity of echo suppressors to a value not greater than that which, referred to zero relative level, corresponds to −30 decibels or −3.45 nepers. This value includes not only the noise present on the toll circuit but also the room noise in the operating rooms at the two ends of the circuit.

(2) To reserve for the present the case of the use of radio-telephone circuits which is the subject of a study now in hand.

PAGE 232.

Replace the section headed "Stability" by the following.

Stability.

The stability of an international circuit under terminal conditions should be at least 0.2 neper or 1.74 decibel (ends open). In the case of four-wire circuits the stability is generally taken to be the same value as the circuit equivalent.

In an international circuit, used for transit service, the active return loss (with respect to the balancing network used in its terminating set) of the national transmitting or receiving system, measured or calculated on the subscribers' side of the input and output ends of the transit circuit, should be at least 0.3 neper or 2.6 decibels for the entire band of frequencies effectively transmitted by the international circuit.

The structural return loss of a repeater section of a two-wire international circuit should be sufficiently high to satisfy the impedance balance requirements. (See "Essential clauses for a typical specification for a repeater section of a loaded international cable," p. 326 of 1934 edition.

The reflection co-efficient $(Z - W)/(Z + W)$ between a two-wire repeater, having an impedance W (measured under service conditions and including the two balancing networks, reaction effects being suppressed (see later, p. 136) and a line impedance Z, should not exceed 0.2 for a medium-heavy-loaded and 0.1 for a light-loaded line for the band of frequencies for which the repeater gives a satisfactory gain.

For the present it is not necessary to fix a minimum limit for the active return loss, measured at a repeater station on a two-wire international circuit, because the condition of the circuit, so far as reflection phenomena are concerned, is sufficiently well taken care of by indicating the stability for which a minimum value has already been given.

PAGE 232.

To the paragraph headed "Propagation Time" add the following Note :—

Note.—The propagation time referred to here is the quotient of the length of the telephone line divided by the velocity of propagation of a continuous sinusoidal wave having a frequency of 800 p : s (the mean frequency of the human voice). The velocity of propagation is the quotient of the angular velocity over the wave length constant (or phase constant) of the telephone line.

PAGE 233.

Substitute the following for the section headed "Transient phenomena" :—

Transient phenomena.

The phase distortion of international circuits should be such that the differences between times of propagation over the whole of the international section of a continental connection do not exceed the following :—

Between the propagation time at 800 p : s and that at the minimum frequency effectively transmitted by the circuit : 10 milliseconds.

Between the propagation time at 800 p : s and that at the maximum frequency effectively transmitted by the circuit : 5 milliseconds.

In the case of an international communication the difference between the propagation time of

the section between the subscriber's terminals and the origin of the intercontinental circuit should not exceed the following values :—

Between the propagation time at 800 p : s and that at the minimum frequency effectively transmitted : 30 milliseconds.

Between the propagation time at 800 p : s and that at the maximum frequency effectively transmitted : 15 milliseconds.

Note.—The propagation time referred to here is the differentiation with respect to the angular velocity w of the phase change (of the circuit or combination of circuits) for the frequency f considered. ($w = 2\pi f$). This propagation time is the time taken to traverse the whole circuit (or combination of circuits) by the peak of the envelope of two sinusoidal waves of very close angular velocities. (w and $w + dw$.)

PAGE 233.

Substitute the following for the section headed "Crosstalk and other Disturbances."

Crosstalk and other Disturbances.

The near end or far end crosstalk between two complete four-wire circuits in the same cable, in terminal service (with the equivalent adjusted to 0.8 neper or 6.9 decibels), must not be less provisionally than 7.5 nepers or 65.1 decibels.

If this condition is met, tests have shown that noise due to babble will be equal, from the point of view of the impression produced on the ear, to a continuous noise giving a psophometric reading not exceeding 0.75 millivolt.

PAGE 234.

From the end of the second paragraph on this page of the section headed "Non-linear Distortion" (commencing on p. 233) and after the words " . . . of which the articulation tests do not take account," replace the text of this section by the following :—

On ordinary telephone circuits the production of harmonics and differential sounds, therefore, has little effect on transmission quality so long as these are within the permissible limits. On the other hand the variation of the equivalent as a function of amplitude has a great effect on stability.

In consequence Administrations and Operating Companies are advised to plot curves showing the variation of the overall attenuation, as a function of frequency, for different values of power applied to the origin of the circuit (point of zero relative level) as follows :—

5 mW – 1 mW – 0.1 mW.

These curves should be sent to the Secretariat of the C.C.I.F. together with the results of observations of the transmission quality (articulation, repetition rate) as well as remarks as to stability. A statistical summary of the separation between the three curves will be made later.

The International Telephone Consultative Committee—

Considering, on the other hand :—

That the length of continental long-distance circuits to be linked up with over-seas radio circuits is limited by the recommendation that the propagation time should be less than 100 milliseconds (see Part 2, Recommendations of principle. Recommendation entitled " Propagation time ").

That this recommendation restricts the length of continental circuits to a maximum of 3 000 km, if light-loaded circuits are used, or even 2 000 km, if due regard is given to the propagation time of secondary circuits connecting the main circuits to the local offices and which must be considered in the longest cables (for example, from London to the East or South-East of Europe and even to Asia. This condition must be regarded as being possible in a not too far-distant future).

Unanimously recommends :—

That it is advisable, in the future, to reserve a limited number of circuits with a speed of propagation, higher than hitherto obtained in light-loaded circuits in the main long cable routes in Europe.

There are several methods for the design of such circuits : for example, the use of 1.3 or 1.4 mm conductors with very light loading and the same repeater spacing as at present (70 to 80 km) or the use of non-loaded circuits, which require shorter repeater spacing.

Very light-loaded or non-loaded circuits permit the application of carrier current telephone operation, which tends to cheapen the cost of telephone circuits.

PAGE 236.

Cancel the two sections headed "Phantoming of International Circuits" and "Interconnection of Four-wire Circuits" and substitute the following :—

NOTE ON ECHO-SUPPRESSORS.

Definitions.

The following definitions concerning the working of echo suppressors are provisionally admitted (see Fig. 1) :—

1. **Various types of Echo Suppressor.**

A relay-type echo suppressor (suppresseur d'echo a action discontinue ; unstetig arbeitende Echosperre) is one which suddenly introduces a fixed attenuation, called the suppression loss, into the return path ; such as for example, an electro magnetic echo suppressor.

A triode valve type or metal rectifier echo suppressor (suppresseur d'echo a action continue ; stetig arbeitende Echosperre) is one which introduces into the return path a progressively increasing attenuation from zero to a final maximum value, which may be greater than or equal to the value of attenuation thought to be sufficient to suppress the echo in the return circuit, which is called the suppression loss. Examples of this kind of echo-suppressor are a triode valve echo suppressor whose action consists in modifying the grid polarisation of a repeater tube and a dry rectifier echo suppressor.

2. **Sensitivity.**

(*a*) **The local sensitivity** of a triode valve or dry rectifier echo suppressor is the value in transmission units (nepers or decibels) of the attenuation which must be inserted between a normal generator* and a pure resistance of 600 ohms across the terminals of which the echo suppressor is shunted to permit of the latter functioning, that is in order that a loss of 0.7 neper may be introduced into the return circuit.

Note.—It is understood that the loss introduced by the echo suppressor into the return circuit, when the voltage applied at the input of the echo suppressor is double that of the voltage applied at the input of the same echo suppressor in the above test, must be very much greater (of the order of 4.6 nepers or 40 decibels.)

(*b*) **The local sensitivity of a relay type echo suppressor** (electromagnetic) is the value in transmission units (nepers or decibels) of the loss which it is necessary to insert between a normal generator and a pure resistance of 600 ohms across which the echo suppressor is shunted to enable the latter to function, that is in order that the armature of the electro magnet in the return circuit may just effect the switching which suppresses the echo in this return circuit.

(*c*) **The zero level sensitivity of a valve or metal rectifier type echo suppressor** is the value in transmission units (nepers or decibels) of the loss which must be introduced between a normal generator and the origin of the circuit (point of zero level) in order that the echo suppressor connected

* A normal generator is a source of sinusoidal current (of interval resistance of 500 ohms and negligible internal reactance) capable of developing a power of 1 milliwatt into a pure resistance of 600 ohms.

to the circuit under normal operating conditions may introduce a loss of 0.7 neper or 6 decibels in the return circuit.

(*d*) **The zero level sensitivity of a relay type of echo suppressor** is the value in transmission units (nepers or decibels) of the loss which must be introduced between a normal generator and the origin of the circuit (point of zero level) so that the echo suppressor connected to the circuit under normal operating conditions may just introduce the suppression loss.

To ascertain the operating time, the hang-over time and the partial closing time of a valve or metal rectifier type of echo suppressor a sinusoidal voltage at that frequency at which the echo suppressor is most sensitive and the value of which is twice the value to define its local sensitivity (that is a voltage which permanently applied to the input of the echo suppressor causes a loss of 0.7 neper or 6 decibels in the return circuit) is applied to or suddenly withdrawn from the input of the echo suppressor.

3. **The operating time of a triode valve or metal rectifier type of echo suppressor** is the interval between the time when the wave defined above is applied to the input of the echo suppressor and the time when the additional loss of 0.7 neper or 6.08 decibels is introduced into the circuit on which the echo is to be suppressed.

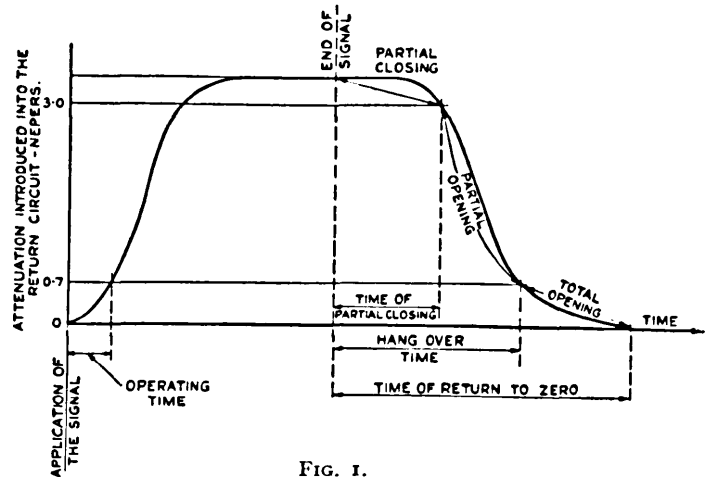


FIG. 1.

4. **The hang-over time of a triode valve or dry rectifier type of echo suppressor** is the interval between the time when the wave defined above ceases to be applied to the input of the echo suppressor and the moment when the additional loss on the circuit suppressed has fallen to 0.7 neper or 6.08 decibels.

5. **The partial closing time of a triode valve or dry rectifier type of echo suppressor** is the interval between the time when the wave defined above ceases to be applied to the input of the echo suppressor and the moment when the additional loss on the circuit suppressed has fallen to 3.0 nepers or 26 decibels.

6. **The operating time of a relay type echo suppressor** is the interval between the moment when the wave is applied to the input of the echo-suppressor and the moment when the armature of the electromagnet introducing the suppression loss has effected the switching.

Note.—Unless otherwise stated the wave applied is a sinusoidal wave of the frequency at which the echo suppressor is most sensitive and whose power is greater by 0.34 neper to 0.57 neper or 3 to 5 decibels than the power which is just sufficient to operate the echo suppressor.

7. **The hang-over time of a relay type echo suppressor** is the interval between the moment when the wave ceases to be applied to the input of the echo suppressor and the moment when the suppression loss is withdrawn.

Note.—Unless otherwise stated the wave applied is a sinusoidal wave of the frequency at which the echo suppressor is most sensitive and whose power is greater by 0.34 to 0.57 neper or 3 to 5 decibels than the power which is just sufficient to operate the echo suppressor.

8. **The partial closing time of a relay type echo suppressor.** In the case of echo suppressors of relay type having a slope on the working curve of practically infinity, and as in the case of a triode valve or dry rectifier type of echo suppressor, but very rapid in which the slope of the falling part of the hang-over characteristic is also very steep the time of partial opening is practically nil and the hang-over time and the partial closing time are practically equal.

The Secretariat of the C.C.I.F. have drawn up, from information contributed subsequent to the Copenhagen Plenary Meeting, a table showing the principal characteristics of the echo suppressors in use in different countries as well as curves showing the operation of these echo suppressors. This table will be sent to Administration and Operating Company members of the C.C.I.F. upon application to the Secretariat of the C.C.I.F.

APPENDIX No. 1.

Calculation of the minimum admissible equivalent for a circuit not equipped with echo suppressors.

To calculate the minimum equivalent admissible from the point of view of echo for a circuit not equipped with echo suppressors it is necessary to know certain essential data as to the conditions which exist on the toll telephone network considered. If these data are not already known, tests on circuits in service must be made so that the results of the calculation may be applicable to actual service conditions.

1. A measurement of the return loss formerly known as " reflection loss " or " echo attenuation " at 1 000 p : s must be made on a large number of pairs in each repeater section of each type of cable. The " return loss " referred to here is that measured in each repeater station (excepting the terminal repeater station) and relative to the line and its balancing network including the equipment associated with each. When a sufficient number of measurements has been made a distribution curve of the return loss values is plotted.

In choosing values of return loss to be used in the calculation described below, it will probably be necessary to take into account the fact that echo effects are produced throughout the whole frequency band. To take care of that measurements could be made at various important frequencies in the relative band for echo (500 to 1 500 p : s) and the results given appropriate "weights." As is indicated in the article, " Factor limiting the minimum admissible equivalent in service of a telephone circuit equipped with repeaters," by L. G. Abraham (*Bell System Technical Journal*, October 1933), in the Bell System 4 decibels are subtracted for this purpose from the value of return loss at 1 000 p : s which is exceeded in 63 per cent. of cases.

2. A measurement must be made at the terminal repeaters of circuits in service of the return loss (in the 500 to 1 500 p : s band) between the network associated with the terminal repeater and each of the various terminations met with in practice (auxiliary lines, subscribers' lines, subscribers' instruments, etc.).

3. A hypothetical net loss value must be assigned to the whole circuit, for which the minimum equivalent admissible in service from the point of view of echo is to be calculated, and also attenuations to various sections of the line and gains to the various repeaters compatible with this hypothetical value.

4. From the distribution curve of return loss obtained as in (1) above, a return loss value for each intermediate repeater must be chosen in the 500 to 1 500 p : s band which, it is estimated, will be exceeded in 63 per cent. of cases.

5. From the values of terminal return loss obtained as in (2) above, a value which will be exceeded

in 95 per cent. of cases must be chosen for each terminal repeater without consideration of the frequency (in the U.S.A. a value of 6 decibels is used).

6. The equivalent must be calculated for each path of the currents which, reflected at various intermediate points of the circuit, flow back to the talker, including the path of the current reflected from the end of the circuit. For the reflection path from any intermediate repeater, it is assumed that this reflection is due to the return loss between the network of that repeater and the corresponding section of the line beyond the repeater from the talker. The equivalent is obtained then for a given path by adding to the return loss value chosen as in (4), the algebraical sum of the attenuations at 1 000 p : s of various sections of the line and of the gains at 1 000 p : s of the various repeaters found on the line considered. The value thus obtained is termed the 1 000 p : s net loss of the path considered, although it should be stated that the return loss may in reality correspond to any frequency within the band 500 to 1 500 p : s. For the path of reflection from the end of the circuit, the return loss value is that selected as in (5).

7. The equivalent at 1 000 p : s for all paths having been calculated, a " weight " corresponding to its total delay is determined for each path. To do this, a delay penalty equal to the minimum equivalent from the point of view of echo which is admissible for a circuit having the same time of propagation as the path considered is subtracted from the value of the equivalent at 1 000 p : s for that particular path. This delay penalty is determined by means of the curve for talker echo which gives the minimum admissible equivalent (from the point of view of echo) as a function of the time of propagation. The value of return loss chosen for the end of the circuit is added to twice the minimum admissible equivalent (read off the curve for the particular time of propagation considered). The echo curve given in Mr. Abraham's article takes into account the value of 6 decibels mentioned above in paragraph (5) and gives directly the lowest permissible echo path for the given total delay, and is the delay weighting term required. The difference between the actual echo attenuation and the " delay weighting term " is called the " weighted " or " corrected " echo attenuation.

8. The " weighted " or " corrected " reflected currents of the various paths are then combined according to the quadratic law (square root of the sum of the squares). To do this the power ratios of the values (in decibels) of the 1 000 p : s equivalents calculated for the various paths (after deducting the corrections of propagation time applicable thereto) must be added together.

9. When the resultant power ratio (obtained by adding the power ratios corresponding to the " weighted " or " corrected " echo attenuation of the various paths) is equal to 1.0, the circuit is considered as being *just* satisfactory from the standpoint of echo. If the ratio is less than 1.0 there is still some margin from the standpoint of echo and the overall attenuation could, if desired, be reduced somewhat. If this resultant ratio is greater than 1.0 the echo is greater than that which is tolerable and the attenuation *must* be increased. If, therefore, it is desired to find the exact attenuation at which the echo is just tolerable, it is necessary to continue as follows :—

If the ratio is less than 1.0 the calculation is recommenced with a smaller hypothetical value for the attenuation of the whole circuit considered. If, on the other hand, the ratio is greater than 1.0 the calculation must be recommenced with a larger hypothetical value of this equivalent. After various trials of this kind a value of attenuation for the whole circuit will be found at which the ratio (calculated as in 8) is exactly equal to 1.0.

The following example indicates how the reflected current of different paths may be combined by using the curve of " delay weighting term " for circuits not equipped with echo suppressors.

Assume a circuit having two possible paths for reflected current. The total delay time on these paths is 50 and 80 milliseconds respectively and their calculated equivalents at 1 000 p : s are 20 and 27 decibels respectively. On the curve in Mr. Abraham's article the minimum equivalent admissible, from the point of view of echo, is 15.5 decibels for a time of propagation of 50 milliseconds, which is

the delay weighting term for the first path. Similarly, the delay weighting term for the second path having time of propagation of 80 milliseconds is 23.2 decibels on the curve. Hence we have :—

	(1) Equivalent of the path Decibels	(2) Total delay of the path Milliseconds	(3) Delay Weighting Term Decibels	(4) Corrected Equivalent of the path (1—3)	(5) Corresponding Power Ratio
1st Path	20	50	15.5	4.5	0.355
2nd Path	27	80	23.2	3.8	0.418
				TOTAL:	0.773

Thus in this example the echo actually produced is only 77.3 per cent. of the total permissible.

10. When determining the propagation time for a certain path it must be remembered that the unbalance between the line and network of a particular repeater is due to the irregularities which occur at various points in the line between that repeater and the next. To take account of this in calculating the propagation time it is assumed that the unbalance is concentrated, not at the repeater (where the return loss was measured), but at a point 6 decibels on its far side. The propagation time is calculated, therefore, for this particular path up to this point 6 decibels beyond the repeater. This correction which applies to 2-wire circuits is not generally, however, of any great importance.

11. The calculations indicated above are repeated for each type of cable and for different lengths of circuit to permit of a curve being plotted with lengths of circuit (of a fixed type) as abscissae and the minimum permissible equivalents from the point of view of echo as ordinates.

APPENDIX No. 2.

CALCULATION OF THE MINIMUM ADMISSIBLE EQUIVALENT FROM THE POINT OF VIEW OF ECHO FOR 4-WIRE CIRCUITS EQUIPPED WITH ECHO SUPPRESSORS AND FOR A COMBINATION OF 4-WIRE AND 2-WIRE CIRCUITS EQUIPPED WITH ECHO SUPPRESSORS.

1. General.

This appendix describes in detail a method of calculating the minimum equivalent admissible from the point of view of echo for a 4-wire circuit both with and without echo suppressors and also for a combination of 4-wire and 2-wire circuits where the 4-wire circuit is equipped with an echo suppressor. This method is based on the use of fundamental curves of talker echo and applicable to circuits equipped with echo suppressors and circuits not so equipped. Methods of plotting such curves by means of appreciation tests are described in the article by Mr. Abraham. Typical curves of this kind as used in the Bell System are given in that article.

In this document is given " the delay weighting term " (correction de temps de propagation) as a function of the total delay (temps de propagation total) on the echo current path both for a circuit without echo suppressor as well as for a circuit equipped with echo suppressors having various values of sensitivity referred to zero relative level. This " delay weighting term " gives the minimum attenuation of the echo path admissible for a certain time of propagation to ensure that the echo effect is not troublesome. The attenuation referred to is, for any path, the sum of all the attenuations and gains from the talker to the point of the impedance irregularity and back to the talker again, plus the terminal return loss to the point of the irregularity within the echo frequency band. In the case of a 4-wire circuit it is twice the equivalent of the whole circuit plus the return loss at the end of the circuit. In the case of a 2-wire circuit having several repeaters it is necessary to consider a number of echo paths since current returns to the talker from each repeater. The method of combining these various echo current paths is given later.

As is mentioned in Appendix No. 1, it is advisable that the various Administrations and

Operating Companies should determine a value of sensitivity, referred to zero level, of echo suppressors which gives a satisfactory margin against faulty operation through noise, and should plot for this value of sensitivity a curve giving the delay weighting term as a function of the total delay. In the discussion which follows it has been assumed that the sensitivity referred to relative zero level is equal to 31 decibels since this value has been found to be satisfactory in the Bell System.

Appendix 1 above described a method of calculating the minimum equivalent admissible from the point of view of echo for a 2-wire circuit. This method requires a certain amount of fundamental data concerning the return losses met with in a telephone network. Similar data are required in the case of a combination of 2-wire and 4-wire circuits. Additional information is also required, as stated by Mr. Abraham in his article, when a circuit equipped with echo suppressors is in question. Having this data the calculation may be made as follows :—

2. Four-wire circuits not equipped with echo suppressors.

In this case the following method is suggested :—

(*a*) As in Appendix 1, choose a value of return loss (for the echo frequency band) at the terminal repeater which will be exceeded in 90 to 95 per cent. of cases. In the Bell System a value of 6 decibels is chosen and it is expected that this will be exceeded in 90 per cent. of cases.

(*b*) Calculate the time of propagation at 1 000 p : s on the whole of the echo current paths.

(*c*) On the curve in Mr. Abraham's article for a circuit not equipped with echo suppressors read as an ordinate the delay weighting term corresponding to the time of propagation calculated as in (*b*).

(*d*) Subtract from the delay weighting term thus obtained the return loss value chosen as in (*a*).

(*e*) Divide by 2 the result obtained as in (*d*) ; the result is the minimum equivalent admissible from the point of view of echo for that particular circuit. To obtain the minimum equivalent admissible in service from the point of view of echo it will be necessary to add a factor taking care of the probable variations in the characteristics of the circuit as a function of time.

3. Four-wire circuits equipped with echo suppressors.

The method of procedure for 4-wire circuits equipped with echo suppressors is similar to that for 4-wire circuits not so equipped, except that the value of the delay weighting term must be read on the curve corresponding to the sensitivity referred to zero level of the echo suppressors used. The curve for a certain value of sensitivity referred to zero relative level is determined as in Mr. Abraham's article.

4. Combination of four-wire and two-wire circuits.

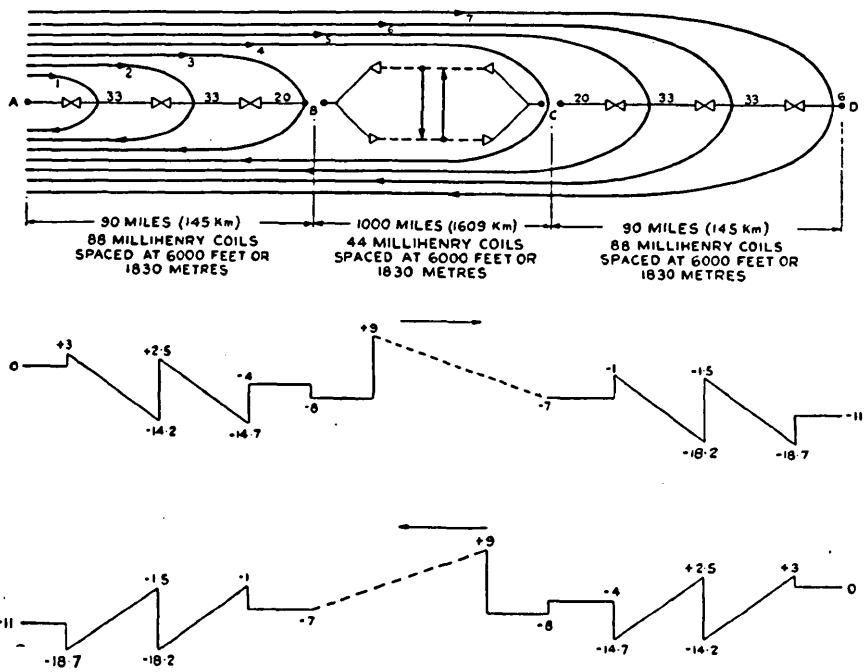
The following method is proposed for the case where 4-wire circuits equipped with echo suppressors and 2-wire circuits are interconnected. If the 4-wire circuit is not equipped with an echo suppressor the combination of 4-wire and 2-wire circuits can be assumed to be an ordinary 2-wire circuit and treated as such as in Appendix 1.

A typical combination of two 2-wire circuits and one 4-wire circuit is shown on the sketch below, which also indicates all the talker echo paths. A value of 33 decibels is assumed for the return loss of each repeater, this value being obtained as in Appendix 1. A similar value is required for the junction point between the 2-wire repeater and the 4-wire terminating set ; on the sketch a return loss of 20 decibels has been shown, which is a typical value obtained under the same conditions in the Bell System. It will be noted that paths 1 to 3 inclusive concern echoes to the talker at A which are independent of the operation of the echo suppressor, while paths 4 to 7 concern echoes to the talker at A which depend upon the characteristics of the echo suppressor. These two groups of echoes are treated differently for the following reasons :—

(*a*) As long as the speech volume of the talker is sufficient to operate fully the echo suppressor no echo can flow by paths 4 to 7. At these higher volumes of speech the only echoes returning to the speaker are those from paths 1 to 3 inclusive.

(*b*) When the speech volume of the talker is not sufficient to operate completely the echo suppressor or if certain syllables are too weak to do so, echoes will flow back to the talker via paths 4 to 7 inclusive. Although under these conditions other echoes will continue to

CALCULATION OF THE MINIMUM EQUIVALENT ADMISSIBLE FROM THE POINT OF VIEW OF ECHO.



Number of Path	Equivalent of Path in Decibels (1)	Total Propagation Time on Path in Milliseconds (2)	Correction of Propagation Time in Decibels (3)	Difference (1)—(3) (4)	Resultant Power Ratio corresponding to (4) (5)
1	33 − 3 − 7.7 = 22.3	0	0	22.3	0.0059
2	33 − 2.5 − 7.2 = 23.3	6.5	3	20.3	0.0093
3	20 + 4 + 4 = 28	13	5	23.0	0.0050
			2.02% of the admissible echo :		0.0202
4	20 + 7 + 7 = 34	124	20	14	0.040
5	33 + 1 − 3.7 = 30.3	124	20	10.3	0.093
6	33 + 1.5 − 3.2 = 31.3	130.5	20.5	10.3	0.083
7	6 + 11 + 11 = 28	137	21	7	0.200
			41.6% of the admissible echo :		0.416

flow back to the talker via paths 1 to 3, the effect will be much reduced owing to the weak speech volume of the talker. In addition, the echoes travelling via paths 4 to 7 will normally arrive much later than those coming via paths 1 to 3. In view of all this the practice in the Bell System is to assume, in cases of weak speech volume, that echoes flowing by all paths between the talker and the echo suppressor may be neglected if these do not give rise to excessive echo when the speech volume is sufficiently strong to operate completely the echo suppressor. In the case of higher speech volume the paths 1 to 3 only need be considered, paths 4 to 7 being neglected.

The detailed method based on the above which is proposed for a combination of 2-wire circuits with 4-wire circuits equipped with echo suppressors is as follows :—

(*a*) Take a hypothetical value of equivalent for the circuit (or combination of circuits for which the minimum admissible equivalent from the echo point of view is to be calculated) and allot the various repeater sections and repeaters such attenuations and gains as will, under medium temperature conditions, result in this hypothetical value of equivalent.

(*b*) From the data obtained as in Appendix 1, choose a typical value of return loss in the echo frequency band at each repeater.

(*c*) From the data concerning terminal return loss, given in Appendix 1, choose a value which will be exceeded in 90 per cent. of cases (in the U.S.A. a value of 6 decibels is taken).

(*d*) Calculate the equivalent of each path by which an echo produced at an intermediate point of the circuit flows back to the talker, including the terminal return path. In each case it is assumed that the reflection at an intermediate repeater corresponds to the active return loss of this repeater (the return loss relative to the section of the circuit beyond the repeater away from the talker and the corresponding balancing network). To obtain the equivalent of each path the return loss chosen as in (*b*) is added to the algebraic sum of gains and losses at 1 000 p : s in the particular path considered. In this way the equivalent at 1 000 p : s of this path is obtained, although, in fact, the return loss can correspond to any frequency between 500 and 1 500 p : s. In the case of the terminal return path the value of return loss chosen as in (*c*) must be taken.

(*e*) When the equivalents of the various echo current paths have been determined in this way, a " delay weighting term " must be applied to each. This " delay weighting term " equal to the minimum equivalent the path may have for the particular corresponding time of propagation and still be satisfactory from the point of view of echo, is subtracted from the equivalent at 1 000 p : s of the path considered. For paths 1 to 3 inclusive the " delay weighting term " is read on the curve for a circuit not equipped with echo suppressor given in Mr. Abraham's article.

(*f*) Echoes flowing back to the talker by paths 1 to 3 inclusive must be combined by adding the power ratios corresponding to the respective 1 000 p : s equivalents less the " delay weighting term " for each path which amounts to combining the echoes according to the quadratic law.

(*g*) The resultant power ratio obtained as in (*f*) gives a fraction characterising the ratio between actual echo effect and the admissible echo effect resulting from the combined echo currents from those particular paths. If this fraction is less than unity the echoes flowing back along paths 1 to 3 may be considered satisfactory. If on the other hand the fraction is greater than unity, the hypothetical value chosen as in (*a*) must be increased and the calculation recommenced until such hypothetical value of equivalent has been chosen as to result in a resultant power ratio (*f*) equal to or less than unity.

(*h*) The weighted echoes flowing back via paths 4 to 7 must then be combined by adding the power ratios corresponding to the 1 000 p : s equivalent less the delay weighting term. Here the delay weighting term is read on the curve corresponding to the value of sensitivity referred to relative zero level, for the echo suppressor used. This method amounts to combining the weighted echoes from paths 4 to 7 according to the quadratic law.

(*i*) The resultant power ratio obtained as in (*h*) is a fraction which expresses the relation between the total echo effect actually caused by paths 4 to 7 inclusive and the echo effect admissible for the particular circuit considered. If this fraction is less than unity a smaller hypothetical value of equivalent for the circuit is chosen and the calculation (*h*) re-made. If the fraction

is greater than unity a larger hypothetical value of equivalent is chosen and the calculation re-made until the calculation (*h*) results in a fraction equal to unity.

(*j*) Having obtained a hypothetical value of equivalent satisfying the conditions as in (*i*), the procedure detailed in (*e*), (*f*) and (*g*) must again be followed to determine if the echo conditions for paths 1 to 3 are satisfactory for this value of equivalent. In the normal establishment of circuits it has been found in the Bell System that the preponderating part was played by paths 4 to 7; a hypothetical value of equivalent which was satisfactory for paths 4 to 7 in general resulted in a very large margin for paths 1 to 3 between the talker and the echo suppressor. If this is not the case it is necessary to re-commence the procedure as in (*e*), (*f*) and (*g*), with various hypothetical values of equivalent, until a value satisfactory for the echo conditions of paths 1 to 3 has been obtained. The minimum admissible equivalent from the point of view of echo for a circuit is the greater of the two values obtained as in (*g*) and (*i*). To obtain the minimum value of equivalent admissible in service an increase must be made taking into account the probable variations in the characteristics of the circuits as a function of time.

(*k*) An example of the application of this method of calculation is given at the bottom of the sketch, in which three sections of a circuit *AB*, *BC*, *CD* have been considered. Calculations relative to echo have been made for a talker at *A* only. Since the connection is symmetrical the same results would be obtained for a talker at *D*. The values 33 decibels and 20 decibels shown on the sketch are the return losses assumed at each repeater where talker echo is produced. To obtain the equivalent for each current path, the net gain between the talker and the point of irregularity and the net gain from this point back to the talker must be subtracted.

(1) In the above example and in the sketch it has been assumed that the echo-suppressor was situated at the middle of the 4-wire circuit and of average sensitivity referred to relative zero level. In the Bell System, when consideration is given to the effect of variations in the characteristics of the circuit with time upon the variation in the sensitivity referred to relative zero level of the echo suppressor, it is generally assumed that, for a circuit whose equivalent is adjusted to its minimum value, the sensitivity referred to relative zero level of the echo suppressor at any one moment will not exceed the average value of 31 decibels. This is the reason for the use of 31 decibels in calculations of the minimum admissible equivalent from the point of view of echo. If it was desired to apply such an example to a case where the echo suppressor is situated at the end of the 4-wire circuit, it is obvious that when the circuit attenuation is at its minimum, the sensitivity referred to relative zero level will be at its maximum value (not counting the effect of the variations of the echo suppressor itself, which are not a function of the variations of the whole circuit). It may be that in calculations of echo suppressors placed at the ends of the circuit, a value of sensitivity referred to relative zero level should be used, which differs from the mean value. Although not mentioned in the above example it appears that this example has been given in a very general fashion so that it may be modified without difficulty for cases where the echo suppressors are situated at the ends of the circuit.

PAGE 239.

At the end of the first paragraph (the penultimate paragraph of the sub-section "Crosstalk and other Disturbances") and after the words ". . . w the terminal apparatus impedance" add a reference to a footnote[1].

And to the same page add the footnote as follows :—

[1] Administrations and Operating Companies who have occasion to make experiments on this subject are asked to advise if this provisional value 0.4 is sufficient both for cases where the lines carry a small number of carrier circuits and also in cases where a large number of carrier circuits are involved.

PAGE 240.

Replace the sub-section headed " Carrier frequency to be used on Circuits yielding one Carrier Circuit in addition to the Ordinary Voice Channel *" by the following :—*

General Characteristics of Multi-Channel Carrier Telephone Systems for Cables with Light or very Light Loading.

The International Telephone Consultative Committee—

Unanimously recommends :—

That the general characteristics of multi-channel carrier telephone systems used on international cable circuits having light or very light loading should satisfy the following conditions, the values given being considered as provisional.

1. Circuits providing one carrier circuit in addition to the ordinary voice channel.

Carrier Frequency and Band Transmitted.—On international telephone circuits providing one carrier circuit in addition to the ordinary voice channel, a standard value, 6 000 p : s, of carrier frequency should be used. On this carrier circuit the carrier wave as well as the upper side band should be suppressed.

Other characteristics.—All other characteristics of the voice or carrier channels should satisfy the general conditions given in the C.C.I.F. recommendation for international circuits used for ordinary telephony (see pages 107 to 114 above, and pages 226 to 233, English Edition, 1934).

2. Circuits yielding 2, 3 or 4 carrier channels in addition to the ordinary voice channel.

(*a*) Carrier Frequency and Band Transmitted.

The carrier frequencies should be complete multiples of 4 000 p : s (4 000, 8 000, 12 000, etc.) and each frequency must be capable of adjustment and must be maintained stable within $\pm$ 5 p : s* approximately. The carrier current must be suppressed as completely as possible, the upper side band only being transmitted.

(*b*) Repeaters.

The intermediate repeaters on the circuit should amplify both the carrier channel current and the low frequency voice channel current. The attenuation distortion of the line should be compensated in each repeater section. The gain of each repeater must be adjustable in steps of 0.1 neper or 1 decibel.

(*c*) Other Characteristics.

The various carrier channels as well as the ordinary voice channel must satisfy the general conditions of the C.C.I.F. recommendation for international circuits used for ordinary telephone (see above pages 107 to 114 and pages 226 to 233, English Edition, 1934) from the point of view of overall equivalent, echo, stability, maximum time of propagation and phase distortion. The far end crosstalk between any entire carrier channel and the entire low frequency voice channel upon which it is superposed must not be less than 6 nepers or 52 decibels.

(The C.C.I.F. will later fix limits for the attenuation of near-end crosstalk between pairs or quads in a repeater section and subsequently for capacity and inductive coupling and for the effects of non-linearity. The levels to be obtained upon the carrier channels will also be fixed later.)

* In cases where the carrier channel is to be used for harmonic telegraphy, the carrier frequency must remain stable within $\pm$ 3 p : s.

APPENDIX.

NON-LINEAR CROSSTALK IN CARRIER CURRENT SYSTEMS.

Non-linearity of repeater tubes makes itself felt in the form of unintelligible crosstalk between the low frequency telephone channel and the carrier channels. There are three distinct effects :—

(1) Interference caused by non-linear harmonics of a low frequency channel on a carrier channel (audio-carrier disturbance).

(2) Interference caused by a carrier channel on the low frequency channel in consequence of the partial rectification of the lateral modulation components which produces audible frequencies (. . . carrier audio-disturbance).

(3) Current modulation of the side band transmitted on a carrier channel by the low frequency voice current passing through the repeaters at the same instant (inter modulation, cross modulation).

The last is the only cross modulation effect, properly speaking, since it is due to modulation currents which are produced when the low frequency and carrier channels are influenced by the non-linearity of the repeater tubes and loading coils. This cross modulation is not produced during the silent intervals on the carrier channel since the carrier current is suppressed on the line, and the cross modulation only appears as a distortion of the speech wave form transmitted.

Happily its effect is shown to be negligible in practice. A series of articulation tests has been made during which it has been noted that the percentage of logatoms correctly received at the end of the carrier channel remained constant whether intense speech currents were transmitted over the ordinary voice channel or not.

With regard to the first effect mentioned above, the crosstalk produced by the voice channel on the carrier channel is due to the harmonics (non-linear) of the speech current whose frequency is within the lower side band transmitted by the carrier channel. The most troublesome is generally the third harmonic of the predominating speech frequency (which is from 1 000 p : s to 1 200 p : s).

In the second effect mentioned above (interference produced by the carrier channel on the voice frequency channel) the components of the side band transmitted on the carrier are partially rectified and this produces audible parasitic components on the voice frequency channel. The resultant noise is quite unintelligible although it has the same rhythm as the conversation.

The first and second effects can be reduced by adjusting the levels at the repeater stations to such a value that no overload sufficient to produce a grid current ever becomes possible, and thus the slight non-linearity of the repeater tube characteristic alone remains. As soon as a grid current is produced the percentage of harmonics superposed on the transmitted speech increases rapidly and raucous sounds are produced on the carrier.

The greater the ratio of the input transformer, the more severe is this effect since the filament-grid resistance seen across the transformer provides a low impedance across the input of the repeater. Obviously one means of reducing the effect of this grid current consists, therefore, in using an input transformer with a small ratio as is the case in the 2-stage repeaters used in Great Britain on toll circuits. Further, the peaks of the speech voltage can be suppressed without affecting the quality of the transmission by means of a smoothing device consisting of dry rectifiers connected in shunt across the input of the low frequency, this device suppressing all peaks of speech voltage exceeding for example 2 volts.

Intermodulation is also produced by the hysteresis of loading coils. Even with modern coils using cores of compressed iron dust the effects of hysteresis are felt on long circuits, due to the increase

of effective resistance of the loading coils. The linear attenuation of a circuit is approximately given by the expression

$$\frac{R}{2} \times \sqrt{\frac{C}{L}}$$

where R is the total resistance per unit length, C the capacity and L the inductance per unit length The increase of the effective resistance due to hysteresis is, for the small telephone currents met with in practice, so weak that it is difficult to measure on a single coil ; but the total effect produced on the attenuation of the circuit is sufficient to give a crosstalk of the same order as that produced by the carrier on the voice frequency channel.

PAGE 244.

Omit the whole of the text under " Section III. Radio Broadcast Transmission *" on pp.* 244, 245 *and* 246 *and continue as on p.* 247 *with the sub-heading :—*

" Electrical Conditions to be considered as a Criterion for the Good Condition of Lines for Relaying Radio-Broadcast Transmission."

PAGE 247.

In the sub-section under the heading " Power Transmitted *" replace "* 500 mW *" by* 50 mW.

After the second paragraph under the heading " Maximum Volume *" add the following text :—*

Assuming (*a*) that the input impedance of the first amplifier controlled by the broadcasting organisation has a value of 600 ohms, pure resistance, throughout the frequency band effectively transmitted by the broadcast circuit,

(*b*) that the relative voltage level at the output of the last repeater of the broadcast circuit equals +0.7 neper or +6.1 decibels,

(*c*) that the maximum voltage at this relative level is 4 volts,

(*d*) that the attenuation of the line between the output of the last broadcast repeater and the input of the first repeater placed under the control of the broadcasting organisation is less than, or at the most equal to, 2 nepers or 17.4 decibels,

Administrations and Operating Companies should (provisionally) guarantee to the broadcasting organisation a maximum effective voltage of at least 0.5 volt at any frequency effectively transmitted by the broadcast circuit, this effective voltage being measured at the terminals of a 600 ohms pure resistance substituted for the first repeater placed under the control of the broadcasting organisation.

PAGE 247.

Substitute the following text for the section headed " Transient Phenomena *" :—*

Transient Phenomena.

The phase distortion index in a circuit or chain of circuits used for broadcast relays should be such that the differences between the times of propagation should not exceed the following :—

Between the time of propagation at 50 p : s (minimum frequency effectively transmitted) and the time of propagation at 800 p : s, 70 milliseconds.

Between the propagation time at 6 400 p : s (maximum frequency effectively transmitted) and the time of propagation at 800 p : s, 10 milliseconds.

Note.—The propagation time referred to here is the differential coefficient in relation to the angular velocity w (which is $2\pi f$) of the out of phase component (of the circuit or chain of circuits) for the frequency f considered. This propagation time is the time taken by the peak of the envelope of two sinusoidal waves of very close angular velocity w and $w + dw$ to traverse the whole of the circuit (or chain of circuits).

PAGE 248.

At the end of the first paragraph under "b. Method of Adjustment" after the words "described below" add, in brackets, (Constant voltage method)[1] and at the bottom of the page add the following footnote :—

[1] If some Administrations and Operating Companies have repeaters for special broadcast circuits for which the constant voltage method of adjustment is not suitable, there is no objection to the use of the constant E.M.F. method of lining up the circuit, even though certain inconveniences are thus caused from the maintenance point of view, provided that the necessary arrangements are made in the frontier stations to change from the constant E.M.F. method to the constant voltage method of adjustment recommended by the C.C.I.F. Nevertheless, new repeaters to be installed or broadcast circuits should be designed for lining up, by means of the constant voltage method.

A third method called the constant internal voltage method has been suggested, but the C.C.I.F. have no experience of it and can therefore make no comment.

PAGE 250.

At the end of the section "Permissible variations in the output levels of a repeater as a function of frequency" add the following paragraph after the diagram "Frontier Station" :—

Adjustable Correctors. The installation on broadcast circuits, say every 150 or 200 km of manually operated correctors (and later of hand or automatic regulators for compensation of temperature variation) should be contemplated. The initial adjustment of these correctors is carried out with care and from time to time this adjustment for taking care of variations in the "equivalent-frequency" curve is checked.

Also add the following section :—

C. Radio-Diffusion.

Arrangements to be made to avoid interference with the international telephone service by the diffusion of speech or music over local or toll telephone lines.

The International Telephone Consultative Committee—

Considering :—

That the radio-diffusion service is often conceded by the Administration or Operating Company to a separate organisation,

That in consequence it is necessary to take every care that the radio-diffusion service does not interfere with the commercial telephone service,

Unanimously recommends :—

1. That, if the radio-diffusion is effected by means of high frequency carrier, crosstalk between the radio diffusion channel and the ordinary voice frequency channel need not be feared.

2. That, if the radio-diffusion is effected at audio frequency (without carrier) no crosstalk is to be feared if the cables used are suitably installed meeting the limits specified by the C.C.I.F. for speech transmission. In no case should the voltage of low frequency radio-diffusion exceed the peak voltage of a sinusoidal wave of an effective voltage of 4 volts at the input of the local telephone line.

Note.—In such a case there is no need to study secrecy which, in commercial telephony, is the main reason for limiting crosstalk.

PAGE 253.

Replace " Section 1. Subscribers' lines and instruments *" by the following :—*

SECTION I. SUBSCRIBERS' LINES AND INSTRUMENTS.

Systems for Recording Messages or Conversations.

The International Telephone Consultative Committee—

Considering :—

That only Administrations and Operating Companies are in a position to appreciate the advisability of permitting systems for recording messages or conversations on their networks,

That where Administrations and Operating Companies have permitted this they would be interested to know the essential technical clauses which should be imposed on such recording devices,

Unanimously recommends :—

That the essential technical characteristics to be recommended for message or conversation recording systems should be as follows :—

Message or conversation recording systems have three applications :—

(*a*) Such a system may be used as an auxiliary to record the conversation exchanged between a subscriber and the party called.

(*b*) Such a system may serve in the absence of the called party to record the message of the caller after advising by means of a suitable sentence that the party called is absent but that a record of the message will be made.

(*c*) Such a system may be used at the traffic control desk of a local or toll exchange.

In order that such apparatus may not cause trouble to the technical service and harm the quality of the transmission it is advisable that it should fulfil the conditions detailed below. The conditions mentioned are not general but are applicable to each specific use of the apparatus.

1. Input Impedance. The impedance of a recording system shunted across a line carrying a conversation must be sufficiently high, at all frequencies above 300 p : s, that the insertion loss does not exceed 0.5 decibel at any speech volume liable to occur during a conversation.

When the recording system, in the absence of the subscriber, is substituted for his telephone, its input impedance must be similar to that of the instrument it replaces.

2. The recording system must be well balanced to earth so as to prevent its incorporation in the line producing or aggravating any noise interference on the telephone circuit. In addition, the battery supply voltage of the recording system must not be productive of any interference on the telephone circuit.

3. There must be a sufficient margin between the fundamental noise of this recording system and its overload point, so that the weakest voice sound to be recorded may be at least 20 decibels above this fundamental noise.

As an alternative, the recording system may incorporate a volume compressor which on the one hand amplifies very weak speech so that for recording purposes it is 20 decibels above the fundamental noise of the recording system and, on the other hand, reduces very loud speech so that it does not overload the recorder.

4. The recording system must reproduce, with sufficient clarity considering the quality of telephone systems, and with a subjective acoustic intensity comparable to that given by a telephone receiver connected across the same circuit, the recorded conversation in a case where the overall

subscriber to subscriber reference equivalent is such that the attenuation between the terminals of the two subscribers' telephones is 3.3 nepers.

5. In order to maintain the secrecy of telephone conversations, a conversation recorded with the greatest possible gain must not be intelligible when the speech volume is 55 decibels below the reference volume.

6. If the recording system incorporates after the amplifier a monitoring device for checking the recording of the conversation in the presence of the subscriber a head receiver only must be used in order to avoid acoustic coupling, this head receiver being connected across a fixed attenuation so that it has a subjective acoustic intensity at the most equal to that of the subscriber's apparatus connected on the line.

7. In the case of a recording system which in the absence of the called subscriber automatically replaces the subscriber's instrument, it must transmit a signal in reply to the ring and then give a spoken indication (by means of a record or film) to advise the caller that the party called is absent but that an apparatus is ready to record a message. The emission of such intimation must be made with a volume which does not exceed those met with in normal telephone conversations.

8. For an easy means of disconnecting the recording system when it becomes out of order and thus avoiding interference with the telephone conversation, a key should be provided for breaking both poles of the connection. In order to minimise the risks in a case of insulation breakdown between the current supply and the connecting leads protective devices of the normal kind used in the country concerned should be incorporated. Lastly, to avoid the production of a ringing signal in the telephone exchange by the operation of the key switching the recorder into circuit it is necessary to insert in each branch of the circuit a condenser of a suitable maximum capacity to avoid interference with the dial impulses or some similar device.

9. The general installation of recording systems should conform to the usual installation rules in force.

Conditions to be satisfied by Subscribers' Telephones liable to be used for International Telephone Conversations and incorporating either Loudspeakers or " radio-diffusion " type Microphones associated with Amplifiers.

The International Telephone Consultative Committee—

Considering :—

That it would be premature to specify conditions to be satisfied by subscribers' telephones liable to be used for international telephone conversations and incorporating either loudspeakers or " radio-diffusion " type microphones associated with amplifiers, since such apparatus is still under consideration,

That it is advisable at the present time to provide information on this subject to Administrations and Operating Companies who are considering admitting such subscribers' apparatus on their networks,

Unanimously recommends :—

1. That Administrations and Operating Companies who wish to allow on their networks telephone subscribers' sets liable to be used for international conversations and incorporating loud speaking receivers or radio-diffusion type microphones associated with amplifiers may note with advantage the two draft specifications which follow : Appendix I. Guiding principles proposed by the German Telephone Administration for admitting subscribers' telephone instruments with loudspeakers into the telephone system, and Appendix II. General conditions proposed by the American Telephone and Telegraph Company for loudspeaking subscriber sets.

2. That the attention of such Administrations and Operating Companies should be drawn to the necessity for recommending that the location of such loudspeakers should be reasonably quiet and not give rise to echo. If this is not done and if subscribers attempt to carry on an international conversation with such apparatus the possibility of having to do away with the latter must be contemplated for certain conversations if the speech quality of such should suffer from room-noise or echo.

Appendices III and IV deal with this subject and give information as to how to ascertain approximately if the acoustic absorption of the room is sufficient.

APPENDIX I.

GUIDING PRINCIPLES PROPOSED BY THE GERMAN TELEPHONE ADMINISTRATION FOR THE ADMISSION, FOR TWO WAY TRANSMISSION, OF LOUDSPEAKING SUBSCRIBERS' SETS.

1. Object of such apparatus.

This apparatus constitutes an accessory to the normal telephone equipment which has the purpose of rendering the use of the telephone less fatiguing to the subscriber and to give him the possibility of letting several persons take part in the conversation if necessary. The subscriber speaks in front of a sound trapping device placed somewhere on his desk at a fixed distance from his mouth whilst he listens to the distant subscriber by means of a loudspeaker.

2. Conditions to be satisfied by such apparatus.

The following conditions must be satisfied with respect to secrecy of the conversations, to the necessity of obtaining satisfactory intelligibility for any line attenuation admissible in service, and from the point of view of absolute stability.

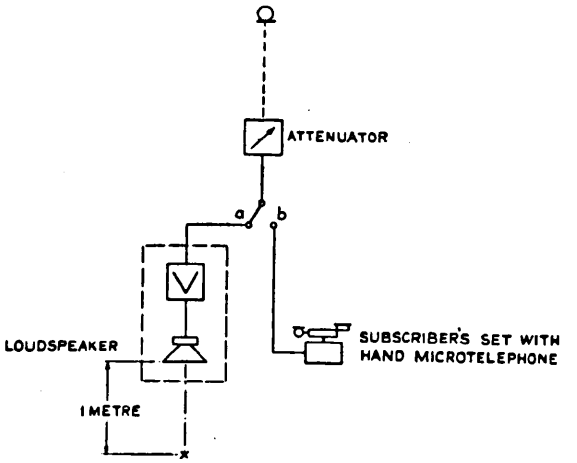
(*a*) Intelligibility. When a loudspeaker installation is connected for two way transmission the distant subscriber who only possesses an ordinary subset must not be penalised in any way. In view of the object of this apparatus its size should be reduced as much as possible. It must be possible to place the sound trapping device and the loudspeaker at a distance of at least 40 cm. from the mouth. The sound trapping device must give a reproduction of speech at least as good in quality as an ordinary central battery microphone. An anti-distortion device for improving the quality of the transmission is both admissible and desirable.

The amplifier gain must be selected so that the intelligibility of the conversation with the distant subscriber will still be good when the attenuation of the line between the two subscribers reaches 3.3 nepers. In special cases apparatus giving a lower gain may be admitted if the attenuation of the line can be guaranteed to be at least 2.5 nepers. In such a case the subscriber should be advised to use the combined handset every time the intelligibility seems to be insufficient.

To determine whether the intelligibility in the above sense is sufficient, normal speech power as defined by means of the volume indicator associated with the German transmission reference system may be used. As minimum speech power received the sound produced in a handset receiver of normal type, over a line of 3.3 nepers attenuation by another handset the microphone of which is spoken into, will be used. The sound perceived in the acoustic field of the loudspeaker at the distance mentioned above and in a silent environment must at least have the power of the minimum speech power received as defined above.

(*b*) Absence of crosstalk. To assure secrecy in telephone conversations the gain of the amplifier and the subjective acoustic intensity produced by the loudspeaker must not exceed the maximum value corresponding to the efficiency of a normal loudspeaker coupled with a normal amplifier in the technical service of the German Telephone Administration (Reichspostzentralamt). To give an idea of this maximum admissible subjective acoustic intensity, use is made of the simplified specification

shown in the figure below. It is no use to limit the acoustic intensity of the sound produced by the loudspeaker when secrecy of telephone conversations is obtained, by special devices such for instance, as by the insertion of coupling limiters (Uebertragungsorgane mit Schwellenwert). The power supplied to the line on the output side should be, under normal conditions, at least equal to that supplied by a subset.



Simplified Specification.

(*c*) Stability of the apparatus. For the values of gain mentioned above under (*b*) the acoustic coupling between the loudspeaker and the microphone should be so reduced that the singing point margin of the apparatus is at least 0.1 neper, when the input terminals of the voice frequency apparatus are short-circuited or insulated. A restriction of the frequency band effectively transmitted to between 300 and 2 400 p : s is admitted if the gain in each direction of transmission is rendered practically independent of frequency by means of an attenuation distortion corrector, the action of which is exerted upon the band of frequencies effectively transmitted. The subscriber is not permitted to modify the singing point margin (Pfeifpunktabstand) ; the margin given above with regard to singing point must be maintained even for the greatest proximity possible between the loudspeaker and the microphone and with the amplifier at maximum gain. It is desirable to fix the distance between the microphone and the loudspeaker.

3. Connecting up the apparatus.

The loudspeaker apparatus may be connected either across the conductors leading to the subscriber's set or to the set itself. This connection must not affect in any way the operation of the subset. The apparatus must include a mechanical or electrical device which reminds the subscriber that he must replace the telephone in the position for receiving rings when he has finished with the loudspeaker apparatus.

4. Construction of the apparatus.

As regards the construction of the apparatus, it must not only have a pleasing appearance, but the assembly of the piece parts must be carefully carried out as well as the wiring.

The amplifier must be made in such a way that the tubes only can be replaced, the remaining piece parts not being accessible to the subscriber. Particular care must be taken to make it impossible for the subscriber to substitute a head-set for the loudspeaker.

APPENDIX II.

USE OF LOUDSPEAKERS IN THE BELL SYSTEM.

At present the main uses of loudspeakers in the Bell System are the following :—

1. Loudspeakers associated with telephone instruments to hold conferences by means of the loudspeakers.
2. Loudspeakers placed at the end of the circuit for the one-way transmission of speech or the transmission of programmes.
3. Paging systems.
4. Public address.

1. Loudspeaker associated with telephone instruments. For loudspeaker conferences, a loudspeaker associated with a small amplifier is normally used ; the amplifier has a 60 decibel gain and an output power of 12 decibels above the reference power.

The amplifier may receive its current supply from the 110 volt direct current network or from alternating supply of from 25 to 60 p : s.

The loudspeaker can be associated with the subset in two different methods. The more usual is by means of a switch by which the conversation may be connected to the subset or to the loudspeaker at will.

In the second method a 3 position key is used ; in two of the positions the conditions are similar to those of the first method, but in the third position both the loudspeaker and the subset are connected at the same time, when the gain of the amplifier is limited and the number of listeners must normally be very restricted.

With the 3 position key arrangement an anti-sidetone subset is always used, having an attenuation circuit for limiting the gain and a special circuit for limiting the possibility of acoustic reaction of the loudspeaker on the microphone.

For some purposes a more powerful loudspeaker may be used with the 2 position key arrangement.

Loudspeakers are normally used for local or toll calls. The distant subscriber uses a hand-set though in certain cases such as multiple conference calls high quality microphones with amplifiers may be supplied.

Although the resulting quality is not comparable with that obtained in broadcasting, it appears to be good enough for the purpose.

2. Loudspeakers for one way direction. A large number of circuits exist for a one way transmission to several terminals equipped with loudspeakers.

Normally speech circuits are used though in some cases broadcast circuits are supplied especially when it is a question of transmitting music.

The loudspeakers used in such cases are generally supplied by the user. The gain of the amplifier associated with the loudspeaker is usually limited to about 30 decibels, a figure which appears to give satisfaction and which does not appear to cause crosstalk trouble in the conditions where loudspeakers are generally used.

The normal rules for the protection of installations are followed and in addition the telephone companies usually install a repeating coil with dielectric strength between windings sufficient to prevent the application of excessive voltage on the telephone circuit in case of faults in the amplifying circuit.

3. Paging systems with loudspeakers. Loudspeaker paging systems have been supplied to shops, hotels, hospitals, etc.

Each system comprises a subset for making the announcements and an amplifier from which leads run to the loudspeakers distributed throughout the building.

The loudspeakers are mounted on walls or tables and are capable of producing a speech sound at least 20 decibels above the reference volume.

4. Loudspeakers for public conferences (Public Address Systems). For public address systems over telephone circuits, high quality microphones with amplifiers and broadcast circuits are generally used.

The loudspeakers and amplifiers at the receiving end are supplied either by the Company or the user, each case being the subject of a special study.

APPENDIX III.

INFORMATION COMMUNICATED BY THE BRITISH POST OFFICE CONCERNING SUBSETS WITH LOUDSPEAKERS IN NOISY OR ECHOING ROOMS.

The details below enable judgment to be made as to whether the acoustic absorption is sufficient in rooms of normal dimensions and shape. The surface of the various room walls is measured and the absorption units are calculated as follows. The various areas are added together after being multiplied by the factors shown :—

		Factor
1.	Floor covered with carpet or mats	0.15
2.	Curtains or hangings	0.1
3.	Furniture not upholstered (the number of pieces is multiplied by the factor)	0.5
4.	Upholstered furniture (the number of pieces is multiplied by the factor)	3.0
5.	Walls, floor and ceiling (including doors and windows and surface covered with carpet but excluding surfaces specially treated acoustically)	0.02
6.	Walls or ceiling specially treated acoustically :—	
	with plaster construction	0.2
	with felt or special perforated absorbent material	0.5

It is thought that the determination of the minimum admissible number of absorption units for any room in which a loudspeaking telephone is to be installed requires a complementary practical experience of loudspeaking telephones. No decision has yet been made as to the most suitable base, whether the total number of absorption units or the number of absorption units per 1 000 square feet.

A few tests have been made by the British Post Office to determine the exact conditions to be satisfied for the best possible reproduction of speech from a microphone which can be used in a room both noisy and echoing.

The tests show that a sufficiently natural reproduction of speech in a room slightly reverberant may be obtained by using a loudspeaker microphone combination or a microphone receiver combination at a sufficiently constant level throughout the useful frequencies.[1] A restriction of this band at either end causes a reduction in the quality of the speech reproduced and a slight increase in the echo effect to the listener.

The presence of a peak in the frequency characteristic (as met with in many types of telephone receivers) at once causes a serious decrease in articulation on the listening side and an increase, also on the listening side, of the noise and echo present at the sending end.

Since the subscribers' receivers in common use have frequency characteristics showing sharp peaks, and since circuits are used, the attenuation of which increases progressively with frequency, it is obvious that noise and echo difficulties cannot be entirely avoided or compensated for by specifications governing the microphone equipment.

[1] A frequency band of from 100 to 3 000 p : s without peaks in the frequency characteristics seems to be reasonable.

Some compensation is, however, possible by using a device which has an increasing frequency characteristic. In these conditions it is necessary to maintain the signal to noise ratio in the neighbourhood of the microphone at a value as high as possible by imposing a strict limit on the distance between the talker and the microphone and by making sure that the microphones, which are designed for use at greater distances than are those used in ordinary telephony, will not be used in rooms liable to excessive noise or echo.

APPENDIX IV.

INSTRUCTIONS GIVEN TO BELL SYSTEM EMPLOYEES FOR INSTALLATION OF LOUDSPEAKING SUBSCRIBERS' SETS.

As is shown in Appendix II above, subscribers in the U.S.A. can be supplied with various kinds of loudspeaking telephones according to requirements. In the most general case where the subscriber wishes to associate a particular type of loudspeaker with the normal type telephone, it has been found that the ordinary installation personnel can, by using the simplified method described below, determine themselves if the acoustic conditions of the proposed location of the loudspeaker are satisfactory. It is recognised that although this method has been simplified to facilitate its practical application, it is based on well known rules of employment of acoustic absorption coefficients to determine if the echo duration of a room is between suitable limits; if in some cases it is found that the acoustic conditions do not appear suitable for a loudspeaker, special steps can usually be taken to improve these conditions.

It is recognised that the speech volume depends upon the various types of loudspeaking telephones used by the parties to the conversation, upon the condition of the line and the conditions of the room in which the loudspeaker is situated. The manner in which the distant subscriber speaks into the microphone is also important. Lastly, the room noise reduces the quality of the reproduction produced by the loudspeaker and everything that can be done to reduce room noise will tend to improve the results obtained.

The presence of carpets, hangings, upholstered furniture, etc. (and also the presence of people in the room), tends to improve the quality of reproduction by reducing the effect of sound reflection.

The following method will permit, in most cases, of judging whether or no the acoustic conditions of a certain room will be satisfactory.

1. If there are carpets, rugs or hangings in the room, note their length and approximate width and take the number in the table given below for these dimensions.

TABLE 1.

Width of carpet or hanging. Feet.	Length of Carpet or Hanging (in feet).									
	5	10	15	20	25	30	35	40	45	50
2	4	8	10	15	20	23	25	30	35	40
4	8	15	25	30	40	45	55	60	70	75
6	10	23	35	45	55	70	80	90	100	110
8	15	30	45	60	75	90	105	120	135	150
10		40	55	75	90	115	130	150	170	190
15			85	115	140	170	195	225	255	280
20				150	190	225	265	300	340	375
25					235	280	330	375	420	470
30						340	395	450	505	565
35							460	525	590	655
40								600	675	750

2. Determine the number of persons who will be present when the loudspeaker is in use, and multiply this number by 10.

3. Multiply the number of upholstered seats by 4.
4. Add the results obtained as in 1, 2 and 3.
5. Note the approximate length and width of the room and take the corresponding number from Table 2.

If the total obtained under 4 does not exceed the number obtained from Table 2 it should be anticipated that the results obtained will not be very satisfactory, due entirely or partially to the acoustic conditions of the room.

TABLE 2.

(See note 3.)

Width of room. Feet	Length of room (in feet).								
	10	15	20	25	30	35	40	45	50
10	30	50	70	90	*	*	*	*	*
15		85	120	160	190	230	265	*	*
20			170	220	270	320	370	420	470
25				285	350	415	480	540	605
30					430	510	585	665	740
35						600	690	785	880
40							800	910	1015

* At least one of the ends of a room of this size should be treated acoustically if satisfactory conditions are to be obtained.

Note 1.—If the surface of the walls or ceiling is treated acoustically an addition must be made to the total of (1), (2) and (3) above. The approximate length and width of each surface treated acoustically is measured and the figure given in Table 1 for these dimensions is taken. This figure is multiplied by 2 and added to the sum of (1) (2) and (3).

Note 2.—In temporary installations where windows or ventilating shafts are open an increase must be made to the sum of (1), (2) and (3). From Table 1 the figure corresponding to the area of these openings is taken and multiplied by 6.

Note 3.—The figures given in Table 3 assume that the height of the room is about 10 feet. If the actual height differs much from this figure the number taken from Table 1 must be corrected in proportion (see the example below).

Example. In a room some 27 feet long and 20 feet wide, with a height of 12 feet, 30 people will be present when the loudspeaker is in use. The room has a carpet measuring 15 × 20 feet.

1. Table 1 gives a figure of 115 for this carpet.
2. The number of persons is multiplied by 10, giving 300.
3. The sum of 1. and 2. gives 415.
4. According to Table 2 the figure for a room 20 feet wide by 27 feet long with a height of 10 feet, will be approximately 250. Multiplying this figure by 12/10 to take into account the real height of the room, a figure of 300 is obtained. As this is considerably less than 415 it may be taken that the acoustic properties of the room will be satisfactory when the audience is present.

PAGE 262.

Replace the last sentence of the first paragraph under " Crosstalk *" by the following :—*

The repeaters will be joined to impedances (Z) having a value equal to that of the uniform impedance fixed for international circuits and the repeaters will be adjusted to their maximum gain.

PAGE 263.

Replace the " Note *" at the top of the page by the following :—*

Note.—The above definition of coefficient of non-linear distortion is deduced from the definition of non-linear distortion given in Part I " Definitions in Telephone Transmission."

Omit the last sentence of the fifth paragraph under " Amplification *" which reads "* In order to bring . . . plate batteries *" and add the following note :—*

Note.—For very long international circuits (more than 12 repeaters being used) this limit is lowered to ± 0.02 neper or ± 0.18 decibel. To obtain this it is recommended that automatic regulators be used on the filament and plate batteries capable of maintaining the voltage constant within ± 2 per cent.

and insert the following paragraph :—

It is recommended that the grid voltage of the repeaters should be maintained constant within 10 per cent.

PAGE 263.

Substitute the following for the text under the heading " Impedance.*"*

Impedance. The impedance of the repeater, not including the line transformers, measured at the input and output terminals at 800 p : s should, in principle, be within the limits specified by the C.C.I.F. for the impedance of international circuits.

The impedance of the repeater, not including the line transformers, shall be approximately equal to that of the circuit with which this repeater will be in service so that the reflection coefficient

$$\frac{Z - W}{Z + W}$$

may be at the most equal to 0.4 for the input impedance of the repeater and 0.6 for its output impedance, Z being the impedance of the line (including the line transformer) and W the impedance of the repeater; these figures should not be exceeded for any frequency of the band effectively transmitted.

PAGE 264.

To the end of the first paragraph under " Crosstalk *" add the phrase:—, and will be adjusted to their maximum gain.*

PAGE 264.

Change the Note under " Non-linear Distortion *" to read :—*

Note.—The above definition of coefficient of non-linear distortion is deduced from the definitions of non-linear distortion given in Part I " Definitions in Telephone Transmission."

PAGE 264.

In the sentence below the diagram commencing " The gain curve of the repeater A-B . . . *" interchange the impedance symbols "* Z_a *" and "* Z_b.*"*

PAGE 268.

Add the following note at the end of part " (5) *" :—*

Note.—There is no necessity in the case of vacuum tubes to specify any fundamental noise values.

As regards microphonic noise it would be advantageous to impose values in the specification. The question is, however, somewhat complicated as it is first necessary to develop a method of measuring microphonic noise and also to fix limits for its size as well as its duration.

In view of the fact that it is not necessary to obtain an international agreement on this subject Administrations and Operating Companies who have established such methods of measurement are asked to send in a description of the same for information and to follow this with the wording of the clause adopted for specifying microphone noise, so that the information may be passed to other Administrations and Operating Companies.

PAGE 307.

Amend the last sentence of paragraph " 4 *" at the bottom of the page to read as follows :—*

As regards two-wire circuits, infra-acoustic telegraph installations must not exceed the values prescribed by the C.C.I.F. in Specification A III below for the exact simulation of the impedance of the line by balancing networks (see Impedance balance).

PAGE 308.

Add a second paragraph to section " 7 *" as follows :—*

Appendix 1 below entitled "Conditions to be fulfilled by infra-acoustic telegraph installations shunted across telephone circuits exposed to risk of danger from neighbouring high tension power lines" contains information on the precautions to be taken for the safety of the personnel and equipment.

Also add a section 9 *as follows :—*

9. The difference in the time of propagation (on a telephone circuit used simultaneously for infra-acoustic telegraphy), at the lowest frequency (300 p : s) and the mean frequency (800 p : s) is increased by an average of 0.5 millisecond for each filter and by 1 millisecond for each repeater section. On the other hand each repeater increases the difference in the time of propagation at the same frequency by 1 millisecond. It follows that high-pass filters inserted in telephone circuits for the purpose of using infra-acoustic telegraphy reduce the range of the telephone circuits to the same degree as the repeaters. For this reason it is recommended that infra-acoustic telegraphy should not be used on telephone circuits of a greater length than 1 600 km admitting 40 milliseconds as the maximum difference in propagation time between the lowest frequency and the average (800 p : s).

PAGE 309.

Ultra-Acoustic Telegraphy. Add the following paragraph to sub-section (4) *commencing at the bottom of p.* 308 *:—*

To prevent interference to the telephone circuit by ultra-acoustic telegraphy the frequency band effectively transmitted by the listening devices in the repeater stations should be limited by low-pass filters of 2 600 p : s. A limitation of the frequency band for low frequencies is not required. It is not necessary for filters to be inserted in the listening devices at the exchanges, seeing that low-pass filters are already inserted at the connecting points of the ultra-acoustic telegraph system. The low-pass filters inserted in the listening devices at repeater stations must not increase the attenuation of the outgoing or incoming telephone current more than 0.2 neper or 1.74 decibel between 300 and 2 000 p : s or by more than 0.4 neper or 3.47 decibels between 2 000 and 2 400 p : s.

Replace sub-sections " (5) *" and "* (6) *" by the following :—*

(5) Where echo suppressors are used in the telephone circuits by-pass arrangements should be provided for the ultra-acoustic channel. To avoid this the insertion of the echo-suppressors could be planned at the two ends of the two wire channels of the four-wire circuit, at the points where the telephone current alone is transmitted. To prevent the telephone current causing interference with the ultra-acoustic telegraph transmission the relative level of power at the output of the line repeaters should not exceed + 0.5 neper or + 4.34 decibels. It is also recommended that volume limiters (smoothing devices) should be inserted either at the input of the first repeater or at its output between the repeater and the low-pass filter. This device should limit the maximum amplitude of the voice to about 4 volts at the point of relative level + 0.5 neper or + 4.34 decibels.

The insertion of low-pass filters in the listening devices is recommended. The attenuation of this filter must be at least 4 nepers (or 34.7 decibels) in the ultra-acoustic telegraph frequency band.

Switching the listening device into the circuit must not increase the attenuation of the ultra-acoustic telegraph channel more than 0.05 neper or 0.43 decibel.

(6) It is recommended that a carrier frequency of 3 540 p : s should be used for ultra-acoustic telegraphy so as to reduce the phase distortion effect on the filters.

(7) Echo suppressors should be placed at terminal stations and not at intermediate stations on telephone circuits used simultaneously for ultra-acoustic telegraphy ; if this was not done it would be necessary to equip the repeaters and echo suppressors installed at the intermediate stations with low-pass filters and to instal a special repeater for ultra-acoustic transmission fitted with high-pass filters to provide for the telegraphic transmission a channel which is not affected by the operation of the echo suppressors.

PAGE 310.

Substitute the following text for Section " IV.*"*

IV. Private telegraph service between two telephone subscribers.

1. A frequency of 1 500 p:s is recommended for private telegraph service between telephone subscribers in the international service.

2. The power corresponding to a continuous signal at 1 500 p:s must not exceed 5 milliwatts at the subscribers' toll exchange in terminal service, and it must be arranged so that the power is as nearly 5 milliwatts as possible.

When the line of the subscriber who desires telegraph transmission has a very high attenuation or a very low crosstalk attenuation, so that interference with other lines in the same network is to be feared, various means exist of avoiding this disturbance while still obtaining a power of 5 milliwatts at the origin of the toll circuit for the telegraph transmission ; in such cases it is for the Administration or Operating Company to choose the means most suited to the circumstances.

3. Voice frequency ringers on telephone circuits used for private telegraph transmission between subscribers must be unaffected by the telegraph signals. It has been observed that a certain type of existing ringer is so affected but steps can be taken to modify such ringers so that no real difficulty is met with at the frequency chosen.

Appendix 3 entitled " Modifications to ringers of telephone circuits used for private telegraph service between telephone subscribers made in Great Britain " gives details as to how such ringers have been modified.

4. It appears that the maximum limit of 250 milliseconds proposed for the hang-over time of echo suppressors on international telephone circuits is not sufficiently long to cause even partial suppression of the name in the response signal.

APPENDIX I.

CONDITIONS TO BE FULFILLED BY INSTALLATIONS OF INFRA-ACOUSTIC TELEGRAPH ON A TELEPHONE CIRCUIT EXPOSED TO RISK OF DANGER FROM A NEARBY HIGH-TENSION ELECTRIC POWER LINE.

For cases of long-distance telephone cables exposed to risks of danger from nearby high-tension electric power lines, to avoid a breakdown of the dielectric between the conductors of the telephone circuits not used for infra-acoustic telegraphy and completely insulated from earth, on the one hand,

and the telephone conductors used also for infra-acoustic telegraphy and momentarily earthed by the line battery on the other hand, there are in principle two different solutions.

1. Between the line inductance coil and the inductance coil at the input of the infra-acoustic telegraph system may be inserted a protection coil (Schutzdrossel) with two windings connected in such a way as to offer a high inductive resistance to the disturbing current which, induced in the line conductors *a* and *b* by the voltage of the disturbing line, flows in the same direction to earth through the battery used for the telegraph transmission but which on the other hand is traversed in the opposite direction by the telegraph current which flows in opposing directions in the conductors *a* and *b*, so permitting the telegraph signals to pass without distortion. If the protection coil is suitably designed the induced voltage is only very slightly lessened on the cable conductors earthed through it so that a difference of potential sufficiently high to break down the insulation between these conductors and those not earthed cannot be produced. Seeing that those pieces of equipment which follow the protection coil cannot be at a high potential from earth since the line battery is earthed there is no necessity to take any special steps for the protection of the operating personnel.

2. The telephone conductors used for infra-acoustic telegraphy can be entirely insulated from earth in the same way as the rest. To effect this, two methods of procedure are available :—

(*a*) The installation of infra-acoustic telegraph is completely insulated from earth by making use of a source of current not earthed in substitution for the line battery. In this case the use of a common battery for feeding the whole of the infra-acoustic telegraph connections must be abandoned ; each must be supplied by a separate battery not earthed. For this purpose dry rectifiers are suitable connected through a transformer to the A.C. supply, if such exists, or to an A.C. generator driven by the exchange battery. Under these conditions the induced voltage in the cable is spread over the whole of the infra-acoustic telegraph installation, the insulation of which must, in consequence, be suitable for the severest conditions which can be expected. To protect the operating personnel, care must be taken to make it impossible to touch the earthed and unearthed parts of the equipment at the same time.

(*b*) Between the line inductance coil and the transmitting and receiving systems of the infra-acoustic telegraph installation, a transformer is inserted which metallically separates the latter from the cable conductors. The source of current feeding the infra-acoustic telegraph remains earthed so that, as before, the operating personnel is protected and can transmit over all the telegraph connections using a common line battery. So that the telegraph signals can pass the transformer, alternating current is used. At the output on the exchange side of the transformer the alternating current is modulated by the telegraph signals, then on the line side of the transformer the signals are retransformed by rectification into infra-acoustic signals by means of additional equipment (see the Appendix below for a description of the arrangement used by the S.E.L.T.).

As far as investigation has gone at present, the method given in 2 (*a*) seems the most suitable ; no change is necessitated in the principle of infra-acoustic telegraph installation ; the actual technical arrangement only differs from previous practice. The operating personnel will be protected by rendering inaccessible all pieces of equipment liable to induced voltage. The racks themselves are earthed as usual. In any case the possibility of protecting personnel by covering the floor with a carpet and separating the earthed portions of the equipment from those portions exposed to high voltage, must be disregarded, for in that case installation of infra-acoustic telegraph would take up too much room and could not be made on the racks commonly used in the operating room.

The maintenance of good insulation of telephone cables and the protection of personnel would lead to an increase in cost and would rob the infra-acoustic telegraph system of part of its economical

attractiveness. Safety precautions, therefore, should only be considered when the telephone cables are exposed to dangerous induced voltage conditions. A special study is to be made to determine when this point is reached.

When the conductors of a telephone cable are closed by repeating coils insulated from earth and from the cable sheath, and the cable is exposed throughout all or part of its length to induction from power lines a longitudinal E.M.F. developed along the cable in the case of a short-circuit of the power line can be tolerated which does not exceed 60 per cent. of the lowest of the following : breakdown voltage between the conductors and the sheath, breakdown between repeating coil windings, breakdown between repeating coil windings and the metallic case, breakdown between loading coils and their metallic case.

If the cable conductors are metallically connected to earth by equipment having a low impedance (infra-acoustic telegraphy) or if the repeating coils are earthed under similar conditions (telegraphy or phantom circuits) the tolerable value of induced longitudinal E.M.F. is less than the breakdown voltage between the cable conductors.

When the parts of the telegraph installation connected to the cable conductors are insulated from earth the admissible value of longitudinal induced E.M.F. on the cable conductors is 60 per cent. of the breakdown voltage of the insulating material separating the insulated parts of the telegraph equipment from the earthed portions.

On the other hand, the direct connection to a cable telephone circuit of an installation usually not too well insulated, risks increasing the unbalance of this circuit to earth and to adjacent circuits ; from this may result an increase of noise.

From these considerations it appears that to obtain the full value of the high dielectric strength of telephone cables and their equipment it is the opinion of the C.C.I.F. that a study is called for to develop telegraph systems allowing all cable circuits to be closed by repeating coils insulated from earth ; the attention of the C.C.I.T. will be drawn to this point.

ANNEXE TO APPENDIX 1.

INFRA-ACOUSTIC TELEGRAPHY ON DISTURBED CIRCUITS

(Note by the S.E.L.T.)

Telephone cables subject to the inductive effect of high tension lines or electric traction lines do not lend themselves to the use of infra-acoustic telegraphy without danger to personnel or difficulties in operation unless certain precautions are taken.

It is desirable, in fact, that the following conditions should be satisfied :—

1. A transformer should be used to separate those pieces of equipment which are directly connected to the cable and those connected to the telegraph apparatus.
2. All equipment in direct contact with the cable should be carefully insulated and any harmful unbalance suppressed.
3. The telegraph signals should be transmitted without distortion in their usual form of successive impulses of reversed polarity.
4. Apparatus should be designed as small and inexpensive as possible and requiring no special supervision.

To satisfy these conditions in the system described the telegraph signals undergo at each end of the circuit or cable used, a double transformation, first into harmonic signals and then into ordinary signals.

To keep all the advantages of the double pole transmission, particularly in so far as telegraphic

distortion is concerned, a new method of harmonic telegraph transmission has been employed as follows :—An alternating current of any frequency is permanently transmitted, an instantaneous reversal is produced at each change of polarity of the telegraph signals, that is to say, at each moment that a start signal follows a stop signal and vice versa.

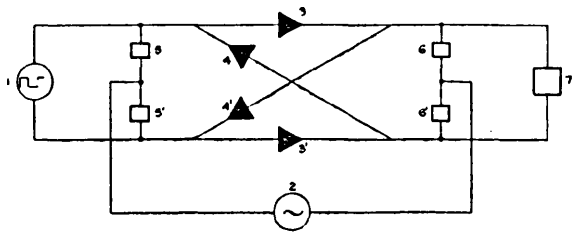


FIG. 1.

Such a transmission is obtained very simply be means of static pole changers with rectifying elements such as those shown in Fig. 1 (pole changers designed by the S.E.L.T.) in which (1) represents a circuit producing telegraph signals, (2) a local source of alternating current, 3 3′ 4 and 4′ are four identical rectifiers, 5 5′ 6 and 6′ balanced impedances and (7) a receiving circuit.

The current in the receiver (7) reproduces that produced by (1), modulated at the frequency of the local current source (2). It produces a special kind of modulated current in which neither the carrier current from the local source (2) nor the modulating current (telegraph current) appears.

This apparatus is reversible and reproduces current identical with the modulating (double pole telegraph) current from the modulated current referred to above on condition that the modulator and demodulator are in synchronism.

The reconstitution at the transmitter and receiver of the signals controlling the demodulator is one of the essential characteristics of this system, but is not used in infra-acoustic telegraphy. The two modulators are actually placed together and are controlled from the same local source of current, in practice, a 500 p : s alternator similar to the machines used for voice frequency ringing.

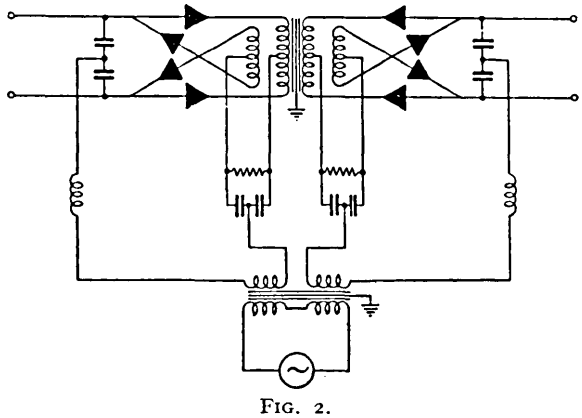


FIG. 2.

Fig. 2 shows a reversible arrangement used for short connections. The modulators are of similar type to those of Fig. 1, chosen because they are capable of a high output. They function as modulators or demodulators according to the direction of the communication at any given moment.

Fig. 3 shows the arrangement used for longer circuits. It is distinguished by advantage being taken of the fact that the signals received are transformed into modulated current in order to amplify them by means of a power valve. The pure demodulated amplified current has a sufficient intensity to pass to the telegraph apparatus without the intervention of a telegraph relay.

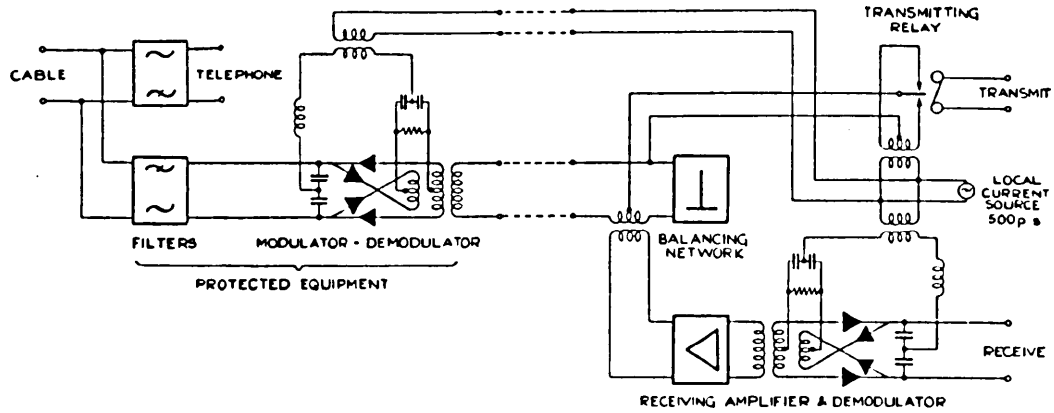


FIG. 3.

At the transmitter where the telegraph current cannot be transmitted with sufficient power, a transmitting telegraph relay is used, the armature of which produces the successive reversals corresponding to the modulation. The isolating transformers as well as the modulator on the cable side must be capable of withstanding any probable induced voltage. They must not create any serious unbalance to earth.

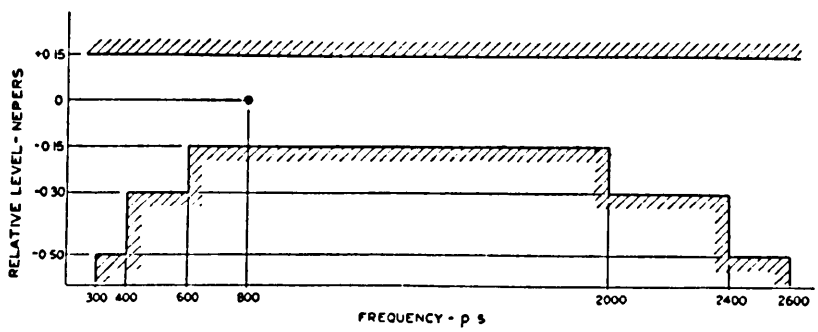
This system has been tested by the French Administration between Paris and Lille and later between Paris and Le Mans. It has been chosen for the telegraph equipment now in course of installation on the cables Paris—Le Mans and Tours—Nantes.

PAGE 311.

Change the heading " Appendix *" to* APPENDIX 2.

Replace the text of paragraph (*b*) *by the following :—*

(*b*) The permissible variations in the relative power level at the output of frontier repeaters are the same as for four-wire telephone circuits as indicated in the graph below, the nominal relative power level (at 800 p : s) having the same value as the equivalent, viz. 0 neper or 0 decibel (see under (*a*) above).



GRAPH NO. 2.

It does not appear necessary to fix special tolerances for variations with frequency of the level measured at the output of a frontier repeater, since they are easily calculated from the tolerances permitted for the relative power levels.

PAGE 312.

Add :—

APPENDIX 3.

MODIFICATIONS MADE IN GREAT BRITAIN TO RINGERS ON TELEPHONE CIRCUITS USED FOR PRIVATE TELEGRAPH SERVICE BETWEEN TWO TELEPHONE SUBSCRIBERS.

Voice frequency ringers used in Great Britain on toll circuits are of two types: (1) Relay type, (2) Vacuum tube type. Both operate at 500 p : s interrupted at 20 p : s.

In the case of receiving devices for relay type ringers, tests have shown that if a filter or tuned circuit is inserted between the ringing receiving device and the line, the margin is sufficient to avoid all risk of false operation due to signals from the private telegraph at a frequency of 1 500 p : s and at the power level recommended. In Great Britain an anti-resonant circuit tuned to 1 500 p : s is inserted in series with the voice frequency relays of the ringer receiving device. The sensitivity of the ringing receiving device has been maintained by adjusting the other equipment of the input circuit.

With reference to ringing receiving devices operating by means of vacuum tubes, three types are in use. The two first were used prior to the introduction of private telegraph service between telephone subscribers, and the following modifications were necessary to render the ringing receiving device insensitive to the telegraph signals.

(*a*) The delayed action relays were replaced by one relay and one copper-oxide rectifier.

(*b*) A voltage smoothing device incorporating copper-oxide rectifiers was inserted at the input of the ringing receiving device.

(*c*) The relay adjustments were rigorously defined.

A third type of ringing receiving device which was developed by the Research Department of the British Post Office has recently been introduced and is now in use in London on the terminal equipment of international circuits. This arrangement is so designed as to obviate all risk of accidental operation due to private telegraph signals.

The table below shows the sensitivity of ringing receiving devices, in decibels, for a power of 1 milliwatt into an impedance of 600 ohms, before and after the modifications.

Type of Ringing Receiving Device	Before Modification		After Modification	
	500/20 p : s Ringing	Private Telegraph transmission at 1 500 p : s	500/20 p : s Ringing	Private Telegraph transmission at 1 500 p : s
Relay Type	—	—	- 5 db	+ 12 db
No. 1 Vacuum Tube Type ...	- 5 db	—	- 5 db	+ 12 db
No. 2 Vacuum Tube Type ...	- 15 db	—	- 10 db	+ 12 db
No. 3 Vacuum Tube Type ...	- 17 db	+ 12 db	—	—

PAGE 316.

Substitute the following for the section entitled " <u>*Automatic Volume Regulators*</u> *" :—*

Volume Regulators.

The International Telephone Consultative Committee—

Considering :—

That it is desirable to ensure a constant output from the radio transmitter despite volume variations caused by the speaking subscriber,

Unanimously recommends :—

That on international radio telephone circuits (with the exception of very short circuits) at the junction between the land line and the radio link a volume regulator, either automatic or manual, should be inserted.

Such regulators are now in use by various Administrations and Operating Companies and are satisfactory under present conditions.

Note 1 below defines the essential conditions which must be satisfied by a comparatively simple type of automatic volume regulator. The numerical values given, which are those of some of the regulators actually in use, are only indicative.

A more perfect regulator is desirable but would necessarily be more complicated.

Notes 2 and 3 give a brief description of such regulators built and tried out by the British Post Office and the American Telephone and Telegraph Company.

PAGE 316.

Change the sub-title " Note *" to* **NOTE 1.**

PAGE 317.

At the end of the sub-section headed " Sensitivity to Noise *" insert Notes 2 and 3 and the recommendation on "* Fading Corrector *" as given below.*

NOTE 2.

The British Post Office has carried out tests with an automatic volume regulator satisfying the following conditions.

1. When the volume at the input varies within a range of 36 decibels the output level remains constant at ± 1.5 decibels (± 0.17 neper) approximately.
2. The initial adjustment takes place within 50 milliseconds.
3. The initial adjustment, having once been made, is maintained unless the input level is subjected to a change which is maintained for about 1 second.
4. When talking stops the automatic volume regulator remains locked at its last adjustment for a period of 10 seconds, and this condition is maintained if voice currents pass over the return circuit during this period.
5. It is possible to adjust the speech volume of the operators whether using the circuit as an order wire or speaking in parallel with the subscriber.

NOTE 3.

The American Telephone and Telegraph Company has produced an automatic volume regulator which includes regulators for both the transmission and reception, and the reaction suppressor, thus providing an apparatus which can be used on two-way service with the minimum of hand regulation.

This regulator maintains the transmission volume within ± 2 decibels for 98 per cent. of subscribers in spite of an observed variation in volume of 45 decibels. Leaving out cases where neither manual nor automatic is capable of giving a satisfactory result, this apparatus gives in service results which are equal to those obtained by manual adjustment. The general characteristics of the output of the device used for test purposes on a London—New York circuit, are as follows :—

1. **General Description.** At a junction point of a radio link with a land line an automatic volume regulator is associated with the switchgear controlled by the speech which prevents singing

and echo. A volume regulator at the receiving end is also associated with these two devices in such a way that each time the adjustment of either tends to cause bad operation due to echo, a suitable attenuation is automatically introduced into the receiving circuit. All these devices for transmission and reception must form an integral part of the radio telephone connection by its association with the 2-wire circuit connecting the radio transmitter and the radio receiver to the telephone circuit.

2. **Range.** The device is so designed that when the input volume varies some 45 decibels, the output volume does not vary by more than $\pm$ 2.5 decibels. For input volume below this 45 decibel range the device does not operate, that is, the adjustment remains where it was when the volume was for the last time below the adjustable range.

3. **Speed of operation.** The speed of the adjustment of the gain and other dynamic characteristics of the device are such that there is no appreciable effect on the effective transmission or on the tone of the voice throughout the range of adjustment. For this purpose the transitory periods differ according to whether the gain increases or decreases. If a loud sound is produced at the input the gain decreases sufficiently quickly so that an overload of the circuit is avoided. If a weak sound is produced at the input, the increase in the gain is delayed for several syllables in case louder sounds follow immediately. In this way, it has been possible to make the adjustment effective while maintaining the variation in volume naturally present in the speech of any one subscriber.

4. **Insensitivity to external noise.** To avoid the accidental operation of the device by noise or echoes it has been constructed so that the slow variation of gain in the rest position does not exceed 2 decibels in about 1 minute, and that noise components outside the frequency band of 600-2 000 p : s have no effect on the gain regulation.

5. **Other characteristics.** The attenuation-frequency characteristic is such that no appreciable distortion occurs within the frequency band 250 to 2 750 p : s nor is there any measurable change in the total phase distortion, in the time of propagation or in any characteristic of the circuit other than those mentioned above.

Fading Corrector.

The International Telephone Consultative Committee—
Considering :—

1. That it is desirable to maintain approximately constant the volume which the radio receiver supplies to the land line in spite of the variations in the volume of the received signal;
2. That the fading of signals at the receiving end of a radio connection varies considerably according to the length of carrier wave used ;
3. That the interest in fading correctors for international radio-telephone circuits is limited at present to short wave operation, to which this recommendation consequently applies ;
4. That the problem of maintaining constant volume at low frequencies is posed in a different way according to the system of modulation used, and that the present recommendation is applicable to cases of modulation of the amplitude of the wave the system which is most commonly used in commercial radio telephony;
5. That in the case of severe selective fading, the fading correctors dealt with in this recommendation would not operate satisfactorily and that in some cases other technical means must be employed, especially the use of several separate antennae and of special radio receivers (see Document No. 22. Answer by the German Administration),

Unanimously advises :—

That fading correctors should have characteristics similar to the following :—

1. **Permanent adjustment.** For variations in the volume of the high frequency at the input,

about 6 nepers or 52 decibels, variations in the volume of the low frequency at the output of the receiver should not exceed ± 0.3 neper or 2.6 decibels throughout the band of frequencies transmitted.

This result is usually obtained by varying the grid potential of the tubes of one or more stages controlled either by the rectified voltage of one tube or by that of several tubes acting separately.

2. **Time constant.** The time constant of this apparatus both for the initial transitory period and for the final period should be able to take several values between 0.1 second and 1 to 2 seconds or even more. It is advisable that the technical operator should be provided with a graduated switch permitting him to select the most favourable time constant value at any one moment. In practice a small number of steps (2 or 3) has been found to be sufficient.

3. **Attenuation distortion.** The fading corrector must only introduce a negligible attenuation distortion at the output of the radio receiving set.

PAGE 317.

Omit the two sections "Interconnections of two radio links . . ." and "Conditions to be fulfilled by Mobile Telephone Stations . . ." on pages 317 *and* 318.

PAGE 319.

At the end of the section "Introduction" add the following paragraph :—

The Note on p. 332 entitled "Test of dielectric strength" deals with the relation between direct current and alternating current tests.

PAGE 322.

To the first paragraph under "Effective Capacity" add the following sentence :—

For each cable the nominal value of this capacity will be given.

PAGE 323.

In the section under "Capacity Unbalance" insert the following between the first paragraph and the table :—

These limits are applicable both for circuits in loaded cable used for low frequency (ordinary telephony) and for circuits in lightly or extra lightly loaded cable giving one carrier channel in addition to the ordinary low frequency channel.

PAGE 325.

Between the sub-sections entitled "Inductance" and "Effective Resistance" insert the following sub-section :—

Direct Current Resistance. The difference between the effective resistance and the direct current resistance of loading coils for side and phantom circuits measured on a loading unit must not exceed the values below in order to avoid excessive attenuation distortion :—

1. For telephone circuits used for voice frequency transmission only : 125 ohms per henry.
2. For circuits operated with one carrier telephone channel in addition to the ordinary low frequency telephone channel : 225 ohms per henry.

3. For circuits giving three carrier telephone channels in addition to the ordinary low frequency telephone channel : 900 ohms per henry.

4. For special broadcast circuits : 180 ohms per henry.

PAGE 325.

Replace the existing text under the sub-heading " Effective Resistance *" by the following :—*

Effective Resistance. The effective resistance of side circuit or phantom circuit loading coils, measured on a loading unit with 1 mA shall not exceed the following :—

1. For circuits used for voice-frequency only : 175 ohms per henry at 2 400 p : s.

2. For circuits used for one telephone carrier channel in addition to the ordinary low frequency channel : 350 ohms per henry at 5 700 p : s.

3. For circuits used for three telephone carrier channels in addition to the ordinary low frequency channel : 1 200 ohms per henry at 14 700 p : s.

4. For special broadcasting circuits : 300 ohms per henry at 6 400 p : s.

Note.—For circuits giving three telephone carrier channels in addition to the ordinary low frequency channel the figure of 1 200 ohms is provisional ; in the future this figure should be lowered.

The additional resistance h due to hysteresis measured at 800 p : s, and expressed in ohms per milliampere and per henry shall not exceed the values given below :—

1. For 2-wire or 4-wire voice frequency circuits only : $h = 12\sqrt{L}$ ohms/mA/H.

2. Circuits operated with from one to three additional carrier channels : $h = 6\sqrt{L}$ ohms/mA/H.

3. For special radio broadcast circuits : $h = 6\sqrt{L}$ ohms/mA/H.

where L is the inductance of the loading coil expressed in henrys.

PAGE 327.

At the end of the sub-section under the heading " Crosstalk *" and immediately before the "* Notes *" insert the following :—*

In the case of short repeater sections (less than 60 km in length or having an attenuation of less than 2 nepers or 17.5 decibels) a far end crosstalk limit of 9 nepers (78 decibels) may be permitted in place of 9.5 nepers (83 decibels).

This minimum limit also applies to near end crosstalk between a 4-wire circuit and an unscreened broadcast pair transmitting in the opposite direction, and to the far end crosstalk between a 4-wire circuit and an unscreened broadcast pair transmitting in the same direction.

PAGE 329.

In " Table B *" make the following change :—*

For cut-off frequency for 1830-88-50 loading the phantom circuit figure should read 4 240 and not 5 000.

PAGE 331.

Change the penultimate paragraph to read as follows :—

In the event of the two countries not following the above recommendations and each country constructing the cable to the frontier, then it will be most advisable to take special steps to ensure uniform construction ; especially should the capacity and inductance standards used in testing by the factories supplying the cable and loading coils be compared and in particular a uniform loading-coil spacing should be agreed. When this procedure is followed . . .

PAGE 332.

At the end of the section "Different Ways in which Two Administrations or Operating Companies can co-operate in the Construction of a Repeater Section which crosses a Frontier" (commencing on page 331) and before the commencement of "Section B," insert the following :—

NOTE.

Test of Dielectric Strength.

1. **General.** If it is desired to obtain a general rule for the substitution of direct current for alternating current in tests of the dielectric strength of any type of cable or apparatus, whatever method of manufacture or type of insulation is used, it may be stated that the data and the results of practical experience hitherto published indicate that the correct constants for a formula for such substitution have not yet been determined. On the other hand, it is normal practice to establish a certain empirical value for the ratio of direct current test voltage to that of alternating current for each particular type of cable or for each piece of apparatus (for instance, a condenser). Such practice, however, must be considered as conventional and as having no relation to the fundamental theory of the subject.

2. **Impregnated Paper.** The most important part of the published works concerning this section of the theory of dielectrics (relation between alternating test voltage and the equivalent direct current voltage) deals with dielectrics consisting of impregnated paper for special power cables. The most important paper on this subject is certainly the Japanese article referred to under No. 3 in the bibliography below.

From these publications it is possible to deduce that :—

(*a*) The ratio of direct current voltage to the equivalent alternating current voltage for testing the dielectric strength of impregnated paper depends upon the amount of humidity in such paper ; the presence of humidity decreases the ratio of D.C. test voltage to A.C. test voltage.

(*b*) The length of time the voltage is applied during the test of the dielectric is an important factor in determining the relationship of D.C. and A.C. testing voltage. In the case of a gradual breakdown of the dielectric the whole process undergoes a change and there is no apparent relation. It must be remembered in this connection that most tests of dielectric strength with D.C. current are of less than 30 minutes' duration ; the more usual tests are those of 15 minutes, 5 minutes and 1 minute.

(*c*) The thickness of insulation appears to have an important effect on the ratio of D.C. to A.C. test voltage. This ratio tends to increase when the thickness of insulation increases since the value of the A.C. voltage decreases whereas that of the D.C. voltage remains almost constant.

(*d*) The ratio of D.C. test voltage to the equivalent A.C. voltage depends upon temperature. It decreases when the temperature increases.

As mentioned above, these remarks apply only to impregnated paper for which, in periodical tests, a ratio of D.C. test voltage to A.C. test voltage in the order of 1.5 to 2.0 is admitted.

3. **Gaseous dielectrics.** If, at the other end of the dielectric scale, the production of sparks in air is considered (see the bibliography below Ref. No. 6 and after) it is found that the D.C. breakdown voltage between two polished spheres must be equal to the maximum A.C. breakdown voltage. This condition, however, is not satisfied in general testing. The other extreme is the combination between a point and a flat surface for which it is necessary to distinguish between two cases. If the point is negative and the flat surface positive the flash-over D.C. voltage appears to be almost double that

when the point is positive and the flat surface negative. In the latter case the maximum value of the A.C. flash-over voltage appears to be equal to that of the equivalent D.C. flash-over voltage. If a dielectric consisting mainly of air is considered, it will be found that no factor exists permitting a direct calculation of the ratio of D.C. test voltage to the A.C. equivalent ; in addition, there will usually be solid substances (for mechanical reasons) in the electrical field, which will produce distortion thus complicating the calculation.

4. **Other dielectrics.** Many combinations of paper and gas are used as an insulator, as in telephone cables, for example, but it does not seem that sufficient published data is available for empirical formulae to be recommended. This is probably due to the wide differences in construction presenting complex combinations of gas and solid substances.

All the same, there is very little information available concerning such solids as mica, glass, bakelite, polystyrene, etc.

In apparatus where such dielectrics are used, flash-overs through air from the surface of the insulator are often the limiting factor and the point and flat surface method is departed from, which results in additional complexity.

5. **Empirical formulae.** For paper condensers and paper insulated power cables, the following empirical formula has been adopted : D.C. voltage = 1.5 × effective A.C. voltage. This formula is prescribed in Specifications 7 and 480 of the British Standards Association for electric power cables. In these specifications, however, this formula is only applicable to cables after laying. The D.C. test is required after placing because the charging current on long cables may be very heavy and it would be almost impossible to obtain a sufficiently powerful transformer to supply the alternating H.T. required for testing the dielectric strength. Notwithstanding it is usually admitted that this 1.5 ratio should logically be interpreted as follows. The maximum A.C. test voltage which can be applied with safety is known and if the D.C. voltage used is 1.5 times as great, it will be certain that no damage need be feared if the cable is satisfactory. It is not admitted that the D.C. voltage producing a dielectric breakdown is 1.5 times the effective value of the A.C. voltage producing a breakdown. This D.C. test has, however, some value, since it occasionally brings to light a fault in the installation tested, due for instance to a defective joint or to the entrance of humidity. In addition, it brings this fault to light in a " peaceful " manner without causing any damage to adjacent cables.

Bibliography concerning tests of dielectric strength with continuous current and alternating current.

1. " The Ratio of Direct and Alternating Current Test Pressures," by N. A. Allen. *Electrical Review*, August 6, 1926, p. 216. (This article contains a bibliography up to the date of publication.)
2. " Testing H.T. Cables," by Beavis. *Electrical Times*, Vol. 77, p. 1078, May, 1930. (See also *Science Abstracts*, Vol. 33, 1930, No. 1 880.)
3. " Dielectric Strength Ratio between A.C. and D.C. Voltages for Power Cables," by U. Takabayasi and T. Syozi, *Electrot. Laborat., Tokyo, Japan, Researches*. No. 358, 1933. (See also *Science Abstracts*, Vol. 37, 1934, No. 1 075.)
4. " On the Electrical Breakdown of Impregnated Papers," by K. Shimizu. *J.I.E.E. Japan Abstract ii*, Vol. 55, No. 2, February, 1935.
5. *B.E.A.I.R.A. Reports* L/F/T 15 and L/F/B 2.
6. *Dielectric Phenomena*, by Whitehead. (Elec. Discharges in Gases.) Pages 124 and following.

7. *Conduction of Electricity through Gases*, by Thomson. Vol. II, p. 568.

8. " Impulse Calibration of Sphere Gaps," by P. L. Bellaschi and P. H. McAuley. *Elec. Journal*, Vol. 31, 1934, *Science Abstracts*, 1934, No. 1759.

9. " Direct Strokes on Transmission Lines," by W. W. Lewis and C. M. Foust. *Gen. Elec. Review* 34, pp. 452-458, August, 1931. Science Abstracts 1932, 102.

10. " Dielectric Phenomena at High Voltages," by Goodlet, Edwards and Perry. *J.I.E.E.* xix, p. 695, June, 1931. (See Fig. 22.)

PAGE 334.

In the section headed " Specification B III " (commencing on page 333) change paragraph 4 to read as follows :—

4. The impedance measured at the output of the terminating equipment which is connected to the jack of the circuit to which it is assigned must have a value lying between 600 and 950 ohms (uniform C.C.I.F. value for the impedance of international circuits and repeaters) when the three other sets of terminals are closed by pure resistances of the same value as the nominal impedance of the lines or repeaters with which the terminating equipment will be used. It is desirable that the impedances be as independent as possible of the frequency.

PAGE 334.

At the end of " Specification B.V. Typical specification for power installations for repeaters," add a new paragraph as follows :—

4. The installation must be so carried out that variations in voltage (of the filament and plate current) do not exceed ± 2 per cent. of their nominal value. In this connection special devices for automatic regulation are advisable to maintain the gain constant (see above under General characteristics of repeaters).

   It is recommended that the grid voltage is maintained constant within 10 per cent.

PAGE 335.

After " Specification B VII " add the following :—

SPECIFICATION B VIII.—ESSENTIAL CLAUSES FOR A TYPICAL SPECIFICATION FOR THE SUPPLY OF REPEATER STATION CABLING.

1. Lead covered cable between the main cable termination and the protectors, or between the main cable termination and the repeating coils if there are no protectors :—

   Dielectric strength. 2 000 volts (effective voltage applied for 2 seconds between all the conductors in parallel and the sheath which is earthed). The tests will be made with an alternating current of 50 p : s.

   Insulation Resistance. 600 megohms per km between any one conductor and all other conductors connected together, to the sheath and to earth.

2. Cabling between the protectors, or the repeating coils if there are no protectors, and the repeater bays.

Dielectric strength. 500 volts (measurement as above).

Insulation. 100 megohms per km (measurement as above).

3. **Crosstalk.** It is recommended that on all the cabling between the main cable termination and the repeater racks there shall be a crosstalk attenuation of at least 8.5 nepers or 74 decibels between 2-wire circuits or 4-wire circuits in the same direction and of 9.5 nepers or 83 decibels between 4-wire circuits in opposing directions.

   From the crosstalk point of view there is no need to distinguish between circuits equipped with repeaters in that particular station and those not so equipped.

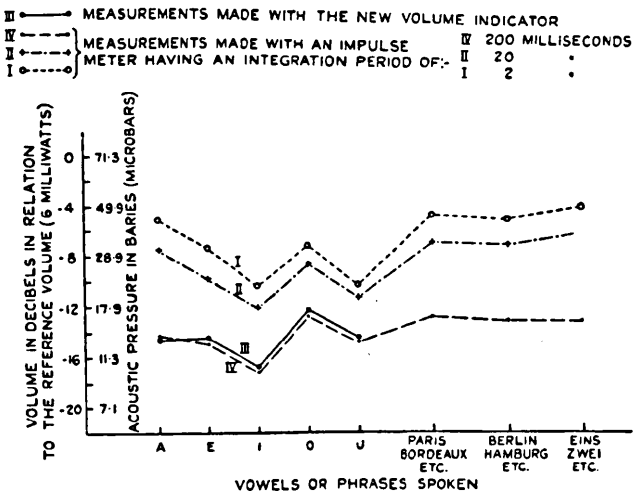
PAGE 354.

At the end of section "B. The Normal Testing Volume to be used in Telephonometric Tests," add the following note :—

Note.—Numerous measurements of speech power have been carried out in the SFERT laboratory using the new Volume Indicator of the American Telephone and Telegraph Company and the Impulse Meter of Messrs. Siemens and Halske. The results of these measurements are given in the SFERT technical reports Nos. 99 and 100.

As the absolute efficiency of the transmitting system of the SFERT is known the acoustic pressure on the diaphragm of the microphone can be calculated from the readings of the Volume Indicator and the Impulse Meter. The absolute efficiency of the transmitting system may be taken as – 31.5 decibels as given in Table I on page 351, bearing in mind that this value was obtained by a calibration made by means of a thermocouple and not by means of a progressive plane wave propagating itself freely.

In the figure below are shown the volume and the acoustic pressure measured in the SFERT laboratory with vowels or phrases for telephonometric tests.



The normal volume for telephonometric tests determined in the preceding tests and equal to – 16 decibels (below the reference volume) corresponds to an acoustic pressure on the diaphragm of the microphone of the SFERT transmitting system of 11.3 bars.

If this normal volume for telephonometric tests had been determined by other operators using logatoms or different phrases and with another method of calibration of the microphone, the results would no doubt have been slightly different ; taking the results of tests made by various Administrations values of between 10 and 14 bars are found.

In consequence it may be admitted that the normal volume for telephonometric tests, corresponds to a mean acoustic pressure of between 10 and 14 bars on the diaphragm of the transmitting system of the SFERT.

APPENDIX 1.—German Administration.

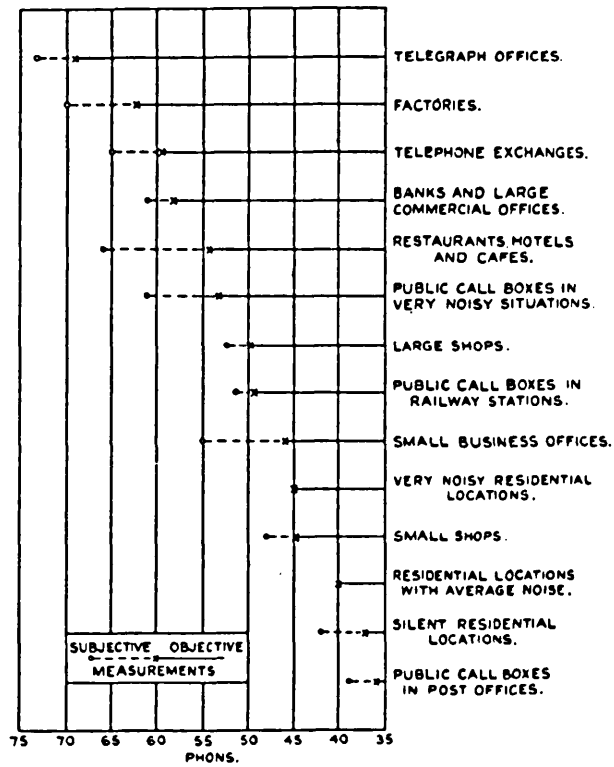


FIG. 1.—Room noise in telephone service.

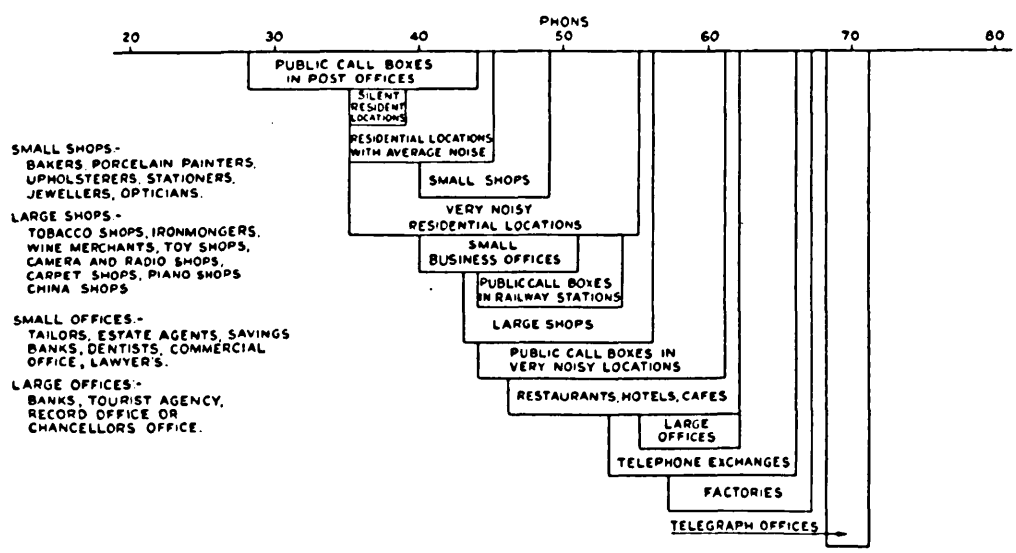


FIG. 2.—Room noise in telephone service.

APPENDIX 1.—German Administration.

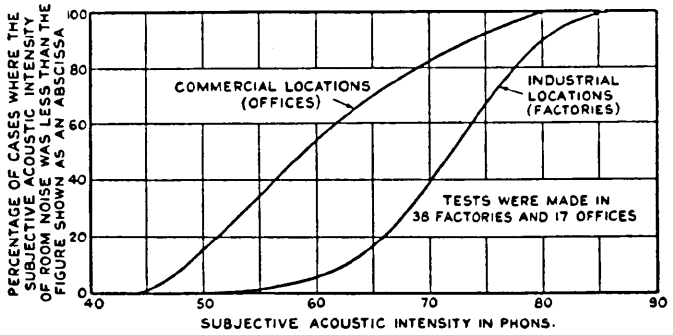


FIG. 3.—Subjective acoustic intensity of room noise in commercial and industrial locations.

APPENDIX 1.—British Administration.

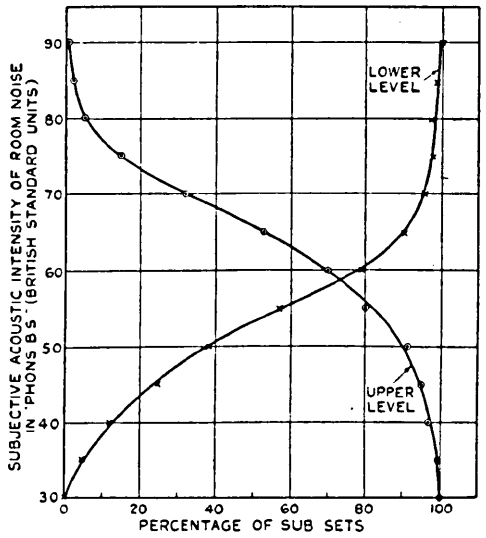


FIG. 4.—Minimum and maximum values of subjective acoustic intensity of room noise in commercial and industrial locations with subscribers' sets.

APPENDIX 1.—Rumanian Administration.

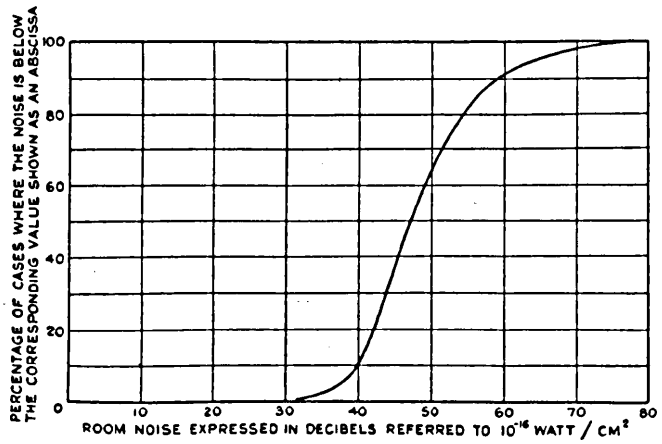


FIG. 5.—Distribution of noise values in an average room (1 090 observations during 15-minute periods between 10 a.m. and noon). The distribution of values observed at Bucharest is approximately proportional to the telephone density.

APPENDIX 1.

American Telephone and Telegraph Company. Room Noise in various locations

1. Data taken from the study made at New York by the Mixed Sub-Committee on Development and Research.	2. Equivalent Loudness in decibels referred to 10^{-16} watts at 1 000 p : s.	3. Data from other sources. A reference number for each source is shown in the next column. The foot-note gives details.	4. Reference number for sources of information other than the source referred to in Column 1.
—	105	Factory	1
Underground railway when an express train is passing the station where the noise test is being made	100		—
	95	Some factories have noise	2
	90	as loud as this.	
	85	Noisy loud speaker in a private house.	4
The most noisy non-residential location tested.	80	Typists' room, noisy restaurant.	3 and 4
Average of 6 factories	75	—	—
—	70	—	—
Information office in large railway station.	65	Noisy shop or office	1
Average non-residential location.	60	Conversation hum in a restaurant. Some localities where people work are slightly less noisy than this.	4
—	55	—	—
		Average business office	1
The most noisy residential location tested.	50		
		Non-noisy loud speaker in a private house.	4
		Quiet commercial office.	1
—	45	Very quiet loud speaker in a flat.	
Quietest non-residential location tested. Average residence location.	40	—	—
—	35	Country house.	1
		Court room at Chicago when empty and with windows shut.	2
Quietest residential location tested.	30		
		Quiet garden in London.	4

Sources of Information given in above table :—

1. A. Fletcher (*Speech and Hearing*, p. 187). Method of ultimate audibility using audiometer No. 3-A with offset receiver. To convert approximately to subjective acoustic intensity 17 decibels are added.
2. D. A. Laird (*Scientific American*, Dec. 1928, p. 509). Method of auditive comparison with the audiometer No. 3A and the standard receiver. The subjective acoustic intensity is read almost direct.
3. W. Waterfall (*Engineering News Record*, 10th Jan., 1927, p. 60). Same method of measurement as in 2 above.
4. A. H. Davis (*Nature*, 11th Jan., 1930, p. 48). Method of auditive comparison or method of ultimate audibility with a diapason producing 600 p : s. The figures given are levels of acoustic intensity referred to the sensation level which is thought equal to the subjective acoustic intensities (noise levels).

REFERENCE ROOM NOISE TO BE USED IN TELEPHONOMETRIC MEASUREMENTS.

The following values should be provisionally adopted for the equivalent loudness (measured objectively by means of a noise meter) of the " reference room noise to be regularly used for telephonometric measurements "* (ultimately this reference room noise will also be used for measurements of effective transmission equivalent) : an equivalent loudness of 50 decibels measured on the American noise meter or of 46 phons measured on the German noise meter.†

A large number of ordinary telephonometric tests should be made with the same reference room noise of 50 decibels.

This value is less than the average value measured in commercial telephone exchanges where international communications are frequently handled, and according to the results of measurements made by the German, British and Rumanian Administrations and the American Telephone and Telegraph Company. (See Appendix 1, pages 152, 153 and 154.)

In consequence, it is desirable for some telephonometric measurements to be made with a higher value of room noise, say 64 decibels (on the American noise meter) or 60 phons (on the German noise meter).

It should be stated, however, that prolonged telephonometric tests made with such a noise and especially with still higher values of noise, may result in considerable fatigue for the operators ; this should be taken into account in carrying out the tests in order to avoid systematic errors.

The above refers only to the equivalent loudness of reference room noise to be used in telephonometric tests and gives no indication as to the nature of the room noise.

In consequence, each time a value of subjective intensity of room noise is referred to, the kind of noise and especially its composition (street traffic noise, murmur of conversation, exchange machine noise, footsteps, etc.) should be stated.

A study should also be made with a view to unifying the nature of these reference room noises. If it is impossible to specify the physical nature of the room noise steps should be taken to ascertain if it is possible to secure universal employment of a special record of which many copies could be made.

For the production of reference room noise (in the place where telephonometric tests are made) most Administrations and Operating Companies do actually use gramophone records on which various room noises have been recorded. On the other hand the Japanese Administration uses a device producing an artificial room noise based on the Barkhausen effect. A description of this device is given in Appendix 2, page 156.

---

* There are at present two scales for the quantitative expression of equivalent loudness, measured objectively :—

(*a*) The scale in decibels relative to a reference zero corresponding to a power of 10^{-16} W/cm² of a progressive free wave at 1 000 p : s (American noise meter).

(*b*) The scale in German " phons " which are decibels above a reference zero value such that 70 phons corresponds to an effective acoustic pressure of 1 bar of a progressive free wave at 1 000 p : s.

† Preliminary tests made in an ordinary room have shown that a mean difference of 4 decibels exists between corresponding readings on the German and American noise meters : further, this difference is not constant throughout the range of measurement and also is dependent on the type of noise considered.

Additional tests should be made under various conditions on the German and American noise meters and will be carried out independently in Germany, Great Britain and the SFERT laboratory. (See later under the recommendation for noise meters.)

APPENDIX 2.

NOISE STANDARD BASED ON THE BARKHAUSEN EFFECT USED BY THE JAPANESE ADMINISTRATION AS REFERENCE ROOM NOISE IN TELEPHONOMETRIC TESTS.

In the opinion of the Japanese Telephone Administration the old types of noise standards have the following defects: they either vary in service following the adjustment of some part of the apparatus or the wave they produce differs considerably from the sound to be measured.

Prof. H. Nukyama of the Imperial University of Tohoku has invented a new type of special noise standard which is considered suitable for the measurement of room noise and which is described below. This noise standard is based on the Barkhausen effect.

If a gradual change is made in the magnetic force acting on a piece of iron, it is generally considered that the magnetic induction in the iron varies gradually in what is known as the hysteresis loop. But in reality, the magnetising phenomena commences with a change of direction of a magnet element which is produced when the magnetic field passes a certain limit of balance and this change of direction is a sudden movement. If one elementary magnet changes direction it forces other elementary magnets to behave in the same way one after the other; if this phenomenon is watched externally an irregular variation of magnetic induction will be observed. By using a coil and an amplifier the existence of an EMF produced by this irregular process of magnetization can be heard. This is known as the Barkhausen effect.

When a special steel is used this effect may be heard at several metres distance by using two or three stages of amplification. To obtain a sustained noise it is necessary periodically to repeat this phenomenon or irregular variation of magnetization.

Figs. 1, 2 and 3 show the experimental apparatus which has been constructed on this principle: it includes a magnetic system of the ordinary kind with balance armature A which revolves on the axis AA. The hatched portion of the armature in Fig. 2 consists of special steel producing a considerable Barkhausen effect, the other part of the armature being made from a non-magnetic material. In the position shown in the figure the flux crosses the armature as shown by the arrow. If the armature turns through 180° the direction of the flux is reversed. If the speed of rotation is n turns per second, the flux changes direction at the rate of $T = \frac{1}{n}$ seconds and at the same time the Barkhausen effect occurs and induces in the coil B an EMF which is led to an amplifier. As it is desirable that the fundamental frequency of the magnetic variation should not fall within the range of audible frequencies, n is given a value of less than 30, and for such a slow speed a clockwork arrangement is the most suitable. If it is desired that the noise should have very small waves it is better to divide the armature into several parts divided from one another by an angle of $\frac{\pi}{2}$ or even less. A series of Barkhausen effects, each separated from the next, is thus obtained in the circuit.

This reference noise is connected as shown in Fig. 3, the room noise to be measured being converted into electric current by means of the microphone M and being compared with the reference noise. Such a noise standard produces a grinding noise similar to that of a wagon passing over sand and gravel. Fig. 4 shows an oscillogram of this noise, the component frequencies of which range from very low to very high frequencies. Fig. 5 shows the values of the Barkhausen effect as measured with a valve voltmeter when the speed of the armature varies from $n = 0.85$ to $n = 1.95$ turns per second. No variation in the quality of the sound is apparent when the speed of rotation varies throughout this interval.

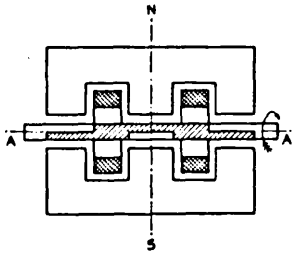


FIG. 2.

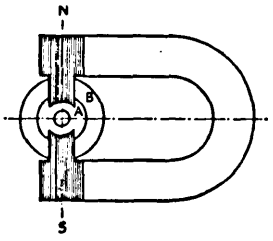


FIG. 1.

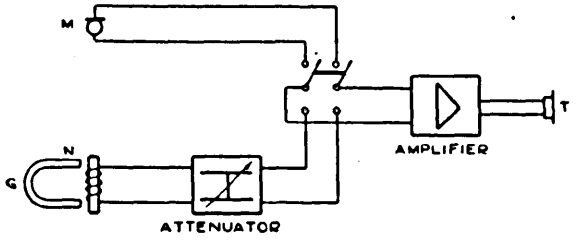


FIG. 3.

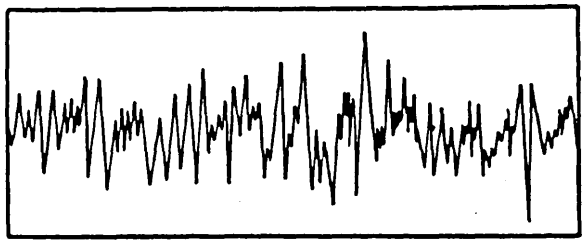


FIG. 4.

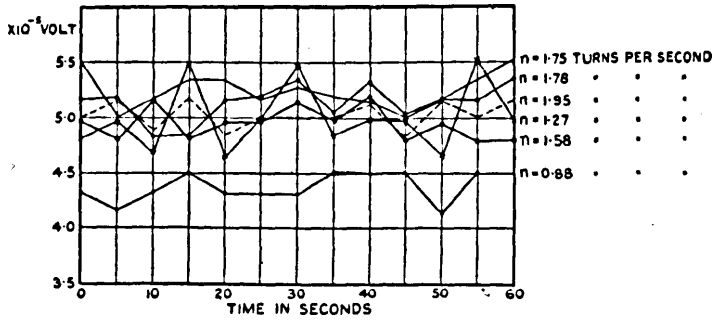


FIG. 5.

PAGE 391.

Under the section entitled (b) " Measurement of the Stability of a Telephone Circuit *" (commencing on page 390), change the third paragraph on page 391 to read as follows :—*

It is recommended that the stability should be determined when the ends of the circuit are insulated. Where high impedance relays are permanently connected across the line during a conversation they may be left in circuit during the stability test. Singing should be observed on the monitoring circuit of one of the repeaters of the circuit or of one of the terminal stations in the case of a carrier circuit.

PAGE 391.

At the end of the first paragraph of the section headed " (c) Measurement of the Singing Margin of a Telephone Circuit, *" and before "* Note 1, *" add a second paragraph as follows :—*

The termination of the circuit during the test consists of a 2 000 ohms pure resistance in series with a 0.5 μF condenser, a combination which gives a balance attenuation of approximately 5 decibels referred to the compromise network (600 ohms resistance in series with a 2 μF condenser). These terminations are installed at all main distribution centres on jacks on the telephone switchboard. They can readily be connected to the circuit under test by means of the normal cord. The circuit is thus terminated in conditions corresponding to the calculation of the circuit plan, during measurements of stability.

PAGE 396.

After the second paragraph of the section headed " 7. Verification of the Battery Voltages and Currents of the Repeater Battery Supply ; Tests of Repeater Vacuum Tubes, *" add the following :—*

It is recommended that the grid polarization voltage of the repeater vacuum tubes should be maintained constant within plus or minus 10 per cent.

The permissible variations of gain for various types of repeaters are given above, under " General Characteristics of Repeaters."

PAGE 445.

At the end of " Note II *" and between that note and the sub-section "* 2, Measurement of Side-Tone Reference Equivalent *" insert the following :—*

Note concerning measurement of reference equivalents. A very clear distinction should be made between measurements necessary for the study and manufacture of commercial telephone apparatus which satisfies as well as possible the conditions of service on the one hand, and on the other hand the interchange among Administrations and Operating Companies of statistical data relating to the reference equivalent of various types of apparatus from the point of view of the reference equivalent as one of the factors influencing transmission quality.

In the first case it is necessary to measure the transmitting and receiving efficiency of the apparatus throughout a large range of variation either of the position of the subscriber's mouth with regard to the microphone and of the volume used or of the strength of the supply current.

In the second case it is sufficient to give for each apparatus a reference equivalent value at the transmitting and the receiving end which corresponds to a suitable position of the mouth with regard to the microphone and a suitable volume measured with a specified volume meter.

The C.C.I.F. only considers this second case, which is why it is not absolutely essential that the conventional position of the mouth adopted should correspond exactly to the average position of subscribers' mouths nor that the normal volume for telephonometric tests should exactly coincide with the mean of the volumes met with in service.

On the other hand there is a great advantage in making universal use of this conventional position of the mouth and the normal volume for telephonometric tests when it is simply a question of passing general data from one country to another concerning reference equivalents.

It is obvious that the values of transmitting and receiving reference equivalent which correspond to this conventional position of the mouth and normal volume for telephonometric tests are not necessarily the same as those given by the same apparatus in actual service.

From these considerations the above conventions concerning the position of the mouth and the normal volume for telephonometric tests can be admitted, although :—

1. The results of head measurements in Europe show especially as regards the angles α and β average values which differ appreciably from those given above, while still remaining in the range of values measured in service. (In fact, the average statistical value found in Europe by numerous measurements made in the past are $\alpha = 22°$, $\beta = 12° 54'$, whilst the values given in the White Book are $\alpha = 15° 30'$, $\beta = 18°$.)
2. Tests carried out, particularly at London, have shown that the normal volume for telephonometric tests is distinctly below the average value used by a subscriber in course of an ordinary telephone conversation.

PAGE 445.

Change the text of the section headed " 2. *Measurement of Side Tone Reference Equivalent" to read as follows :—*

The general rules specified for the determination of the mean value of side tone reference equivalent of telephone apparatus under service conditions are as follows :—

The tests must be made by the ear or by an equivalent device.

Two kinds of side tone must be considered, speech side tone and room noise side tone.

The determination of speech side tone reference equivalent must be made by the voice or by an equivalent device ; the volume to be used in these tests is the normal volume for telephonometric tests.

The determination of room noise side tone reference equivalent must be made with room noise having the reference value of equivalent loudness.

When stating the result of a measurement of the reference equivalent of side tone of a telephone apparatus, the following should also be stated : the value of the impedance to which the telephone apparatus was connected during the test, the intensity of the microphone current, and the transmitting and receiving reference equivalents of the particular telephone apparatus.

The detailed description of methods of measurement used for the determination of speech reference equivalent of side tone and that for room noise follows.

and continue as on page 445 *:—*

" (*a*) If it is a question of speech side tone . . ."

PAGE 447.

To sub-section "a" under section headed "2. Measurement of Side Tone Reference Equivalent" (commencing on page 445), add the following :—

The French Administration uses the following method for measurement of the reference equivalent of side tone. The transmission equivalent of side tone of a telephone set with microphone M and receiver R, is measured by comparison with the Working Standard and referred to the Reference System. For this purpose the telephone set is considered as a transmission system from the microphone to the receiver of the same set. As, however, its equivalent is usually small, it is necessary to reduce the volume of sound in the receiver which greatly facilitates the carrying out of the measurements and avoids an excessive diminution of the attenuation in the standard system. This reduction is obtained by an additional attenuation being interposed between the telephone set proper and the receiver R1, which is disconnected and replaced by a receiver R_2 of the same type, characteristics and efficiency. To the terminals of R_2 is connected the input of an attenuator S to the output of which is reconnected R_1. The input impedance of S is large compared to that of R_1, so as not to modify to any extent the normal operation of the set. The output impedance of S is adapted to that of R_2 in conditions similar to those of the set with regard to its receiver.

The sequence of measurements is as follows :—

1. Telephonometric determination of the equivalent b_1 of the attenuator system when the subset is normally fed by a SETAC system (or any other system corresponding to practical conditions) into the microphone of which normal conversational tones are spoken. This measurement may be replaced by the determination at a single frequency of the ratio of the voltages at the terminals of the two receivers when an alternating EMF is applied to the microphone terminals.

2. Telephonometric measurement of the side tone b_2 of the modified telephone set with regard to the standard system ; b_2 includes all the attenuation inserted between the transmitting system and the receiving system.

   The difference $(b_2 - b_1)$ corrected if necessary for the equivalents of the microphone and receiver used, gives the value of the side tone of the set under test.

   The measurements indicated above are made either with the working standard system or with the typical battery supply systems and cables.

   The value of b_1 mentioned above, is generally 2 nepers but may be greater or smaller according to the magnitude of the side tone studied.

   Lastly, for the determination of the optimum condition of side tone of subscribers' telephone apparatus, the procedure may be as follows, as suggested by the German Telephone Administration.

   By reason of the existence of side tone in the telephone apparatus itself, the subscriber hears in his receiver at the one time both his own speech and the room noise trapped by his microphone. On the other hand, it is well known that the quieter his own voice appears to him the louder will he speak and vice versa.

   Further, the articulation of a conversation depends upon the strength at which it is received, it is optimum at a volume corresponding to a reference attenuation of between 2 and 3 nepers ; in consequence, when the attenuation of the line is small, the articulation will be better if the subscriber speaks quietly, and when the line attenuation is great the articulation will be better if the subscriber speaks loudly.

Due to the existence of room noise the subscriber will have worse reception the weaker the volume he receives from his correspondent and the greater the room noise.

The volume received from the distant subscriber is fixed by the attenuation of the line b_L and the volume of room noise received depends upon the reference equivalent of side tone b_R.

The articulation of a conversation troubled by noise depends mainly, for average values of noise, upon the ratio of the speech voltage to the noise voltage.

The articulation n is thus determined by the formula :—

$$n = \frac{E_{T_2} \times e\text{-}b_L}{E_R \times e\text{-}b_R}$$

Where E_{T_2} is the speech voltage at the output of the subset of the distant talking subscriber, and E_R the room noise voltage at the terminals of the microphone of the listening local subscriber. The receiving reference equivalents of all telephone apparatus of the same type are approximately equal and in consequence need not be considered.

For a given articulation, therefore, we have :—

$$b_R = b_L + \text{a constant.}$$

To obtain the same value of articulation for all communications the reference equivalent of side tone must therefore increase with the attenuation of the line, and both manifestations of side tone, the hearing of one's own speech and the hearing of room noise tend to realise the same condition.

PAGE 459.

Omit the introductory paragraphs of the section headed " Measurement of Articulation," *and insert the following :—*

Measurement of Articulation.

The International Telephone Consultative Committee—

Considering :—

That it is not yet possible to formulate definite detailed guiding principles for carrying out international measurements of articulation.

Unanimously recommends :—

That it is advisable to follow the general provisional guiding principles given below for the measurement of articulation.

and continue with the existing text from :—

" (*a*) **Logatoms to be used. . . .**"

PAGE 459.

At the end of section " (a) Logatoms to be used," *insert the following note :—*

Note.—Experience has shown that it is desirable to use a greater number of vowels than the five used in the esperanto logatoms. In some cases the articulation for vowels is greater when using esperanto logatoms than when using logatoms from various languages. This is due to the languages possessing more than five vowels and it is therefore more difficult to recognise the vowel sound transmitted.

But the use of a larger number of vowels does not seem to be possible from the international point of view owing to the difficulties of pronunciation of operators of the different countries, and it is recommended that the use of esperanto logatoms should be continued. Nevertheless, to render tests made using different types of logatoms more comparable with one another it is recommended that for a certain time articulation for consonances and that for vowels should be shown separately.

PAGES 459-461.

Replace the text commencing " *(b) Operating Method* " *on pp.* 459, 460 *and* 461 *down to* " *Appendix A* " *by the following :—*

(*b*) Method of pronouncing logatoms—Use of test phrases—Control of volume.

The logatoms should be read successively over the testing system by the operator who should speak in a uniform tone of voice at the voice intensity used in telephonometric tests ; he should speak distinctly and without exaggerated articulation, at a definite speed, for example, one logatom in three seconds.

It is recommended to try out the other method consisting of inserting the logatom in a very short phrase of three or four words called a test phrase.

The records should cover especially variations in accuracy of the results and the fatigue of the operators for both methods, isolated logatoms and logatoms in test phrases. It is thought that one of the advantages of the latter method would be to permit of a more effective control of the volume.

For these test phrases syllables should be chosen which give normal and approximately equal deviations on the volume indicator.

It is recommended that the SFERT laboratory should endeavour to find a test phrase which could be spoken by operators of different countries, this phrase being made up of three or four esperanto logatoms taken from the test lists.

When the enunciation of logatoms is carried out by means of test phrases, the talking speed will be determined by the phrase used and should approximate that of a phrase every three seconds.

(*c*) Recording the logatoms—Correction of results—Rest periods.

The listening operator or operators record the logatoms as they understand them at the receiving end of the system. When the reading and recording are finished a comparison is made between the logatoms transmitted and received, and a record is made of the proportion of correctly received logatoms. It is preferable that the operators taking part in the test should not themselves correct the results but no general rule can be laid down because of the need for taking into account several factors such as the difficulty of the test, the method used in enunciating the logatoms, the training of the operators, etc.

In any case care should be taken not to fatigue the operators.

(*d*) Method of distributing the tests—Number of logatoms received per test point.

In the case of comparative tests on two or more systems it is recommended to read successively a list of logatoms over each system to be studied.

Experience has shown that if the number of logatoms received by an operator in one day exceeds 1 200 the results may be inaccurate due to fatigue or over-exertion, even this number, 1 200, may be too high in cases of difficult transmission.

The number of logatoms received per test point depends mainly upon the general circumstances of the test ; no definite figure can be recommended.

It is desirable that each operator speaks in turn, the other four listening at the receivers which are so installed that the impedance, side tone and supply conditions are normal.

(*e*) Various methods of making articulation tests.

To make use of lists (or cards) of logatoms, a logatom printing machine can be used, the principle of which is as follows. The machine has three wheels : the two outside wheels carry printer's types of consonants or " consonances " in Esperanto, and the middle wheel similarly types of vowels. The

three wheels are set at random, and a key is depressed which causes a logatom to be printed. In this manner a list of logatoms is obtained and this list is used only once.

The logatoms may be recorded on individual cards, each card containing but one logatom. When a test is to be made cards are drawn at random from a pack. The cards as drawn are then placed in a suitable container. The talking operator picks up the cards in sequence, reads out the logatoms and places the cards in another container in the order of reading.

(*f*) Selection of operators for testing crews—Number of operators per crew—Training of operators.

In selecting operators for a crew it is advisable in the first place to submit them to a physiological test as to speech and hearing; they will then be tested in transmitting and receiving speech on a transmission system which includes commercial subscribers' apparatus with various attenuations, either with or without noise. Those operators who differ too greatly from the average obtained from a large number of operators or whose results vary too much, should be eliminated.

At least five separate operators should be used in an articulation test ; a still larger number would be preferable, forming one or more crews. In this way excessive habituation of the operators with one another and their over-training, both of which should be carefully guarded against, would be avoided.

(*g*) Calibration of testing crews—Transmission system used for such calibration—Experimental practice coefficient.

It is well known that various testing crews are influenced in their results by the amount of training they have had and by their physical condition. In order to obtain comparable results, it is therefore necessary to make a correction by applying an experimental practice co-efficient.

It is essential to state whether published results are corrected or not by the application of the experimental practice co-efficient. Also, in order to compare the results of different tests, the data should always be accompanied by a precise indication of the number of logatoms received.

It is essential that the reference equivalent of the circuit, over which the articulation test is made should be given in the report of the test.

Regarding methods to be used in correcting the results of articulation tests in order to allow for the practice co-efficient of the test crew, the C.C.I.F. cannot for the present make a final recommendation.

Nevertheless, since it is necessary to correlate, as soon as possible, the results obtained with more or less experienced crews of different nationalities, it is even now desirable and practicable to recommend a tentative method of correction.

Two methods have been suggested as temporary expedients ; one of them is described in Appendices B_1 and B_2 and the other in Appendix C, below.

Although the experience gained up till now is not as great as one might wish, it is nevertheless a fact that the results obtained with various crews, using the first correction method, do not differ greatly from one another.

The C.C.I.F. therefore recommends that provisionally the results of articulation tests shall be corrected as far as possible in accordance with the methods described in Appendices B_1 and B_2 and shall be expressed preferably in terms of ideal sound articulation.

In cases where it is only necessary to determine the effect on articulation of a small change in one variable of a system it is sufficient to ascertain the difference between the articulation measured before and after the change of the variable, indicating, however, that the figure obtained is the uncorrected difference in articulation for logatoms.

The following should be taken into account in the application of the methods quoted for the calibration of articulation testing crews.

The object of this calibration is to correct the results of articulation tests in such a way that the final values obtained should be independent of the crew making the test and of the time at which they were made.

The first step is the standardisation of technique recommended above.

By means of subsequent tests using this standardised technique it is hoped to obtain details on the utility of methods of calibration which will ultimately permit the selection of the most suitable calibration method.

Experience has shown that a small crew can be calibrated effectively when the system to be tested and the calibration circuit do not differ materially from one another.

On the other hand, it may be expected that in a fairly large crew differences other than those solely due to the state of training of the operators would disappear and that an experimental practice co-efficient determined by means of a single calibration circuit, could probably be established.

On the subject of Note C below, if it is desired to calibrate articulation crews in accordance with the directions given therein, it must be remembered that calibration systems have not yet been specified of which the characteristics are sufficiently close to those of the various systems to be studied from an international viewpoint.

It is desirable that agreement should be obtained as to the characteristics of one or more universal calibration systems taking account of the various factors affecting telephone transmission quality.

With reference to Notes B_1 and B_2 below, it would appear possible from the data relative to one crew to calculate the articulation which the same crew should obtain on any system (see Dr. Collard's article on pages 153 to 194 of the *Livre Jaune*, Brussels, 1930, English edition pages 83 to 108), but it has been noted that a crew of 5 operators is too small to enable universal and reproducible values to be obtained.

PAGE 491.

Change the " Note *" under "* B. Impulse Meter *" to read as follows :—*

Note.—For volume measurements during a broadcast transmission (relay of a broadcast programme via a telephone circuit) provisionally a maximum impulse meter should be used which is suitable for a frequency band of from 30 to 7 000 p : s and which uses full wave rectification, the difference in sensitivity for both directions of the current not exceeding 1% of the deviation obtained with a permanent sinusoidal current at all frequencies effectively transmitted (30 to 7 000 p : s).

PAGE 499.

Change section " A. Artificial Voice . . . *" to read as follows :—*

A. Artificial Voice : Guiding Principles in Studying Apparatus Intended to Replace the Human Voice in Telephonometric Tests or in Articulation Tests.

In considering an artificial voice there is need to distinguish clearly in the C.C.I.F. document three possible uses as follows :—

1. Laboratory Tests. Measurement of reference equivalent or efficiency.
2. Tests of subscribers' apparatus in service (maintenance).
3. Acceptance tests in the factory of telephone sets.

The C.C.I.F. recommendations should only be applied to the first two cases.

1. For tests and measurements in the laboratory the guiding principles for the study of an artificial voice (mechanical device for replacing the human voice in telephonometric measurements or articulation tests) are as follows :—

The results obtained with the apparatus must correspond as closely as possible to those obtained when using the human voice.

It is desirable that the band of frequencies effectively transmitted should include the greater part of the band used in a conversation. A band of from 100 to 8 000 p : s appears suitable for use in making articulation tests.

The acoustic field in front of the apparatus should have a distribution as similar as possible to that in front of a talker's mouth. This may be a matter of importance in determining the variation in efficiency as a function of the distance of the mouth from a microphone ; for any one type of microphone under test this variation must be the same with the artificial voice as with measurements made using a human voice.

The apparatus must be capable of producing, without non-linear distortion, a volume at least 16 decibels above the normal volume for telephonometric measurements.

Experience has indicated that not only is it necessary for the diagram of the distribution of energy of the sound produced by the apparatus to correspond to that of speech sounds, but also that the amplitude of the sounds should vary in a similar manner to that of a continuous conversation.

The apparatus must be stable and capable of being exactly reproduced.

Note.—It appears neither possible, nor at present desirable to further particularise the guiding principles referred to above ; it is sufficient if the various Administrations and Operating Companies, who have developed an artificial voice which satisfies these general conditions, send to the Secretariat of the C.C.I.F. a detailed description of the apparatus and its method of use.

Appendix 1 below describes an artificial mouth used by the German Administration as well as the acoustic spectrum of this apparatus and also the results of comparative measurements of transmitting and receiving reference equivalents made partly by the use of the human voice and ear, and also by the use of the artificial mouth and an artificial ear consisting of a high quality carbon microphone coupled to a receiver followed by a filter circuit, a rectifier and a galvanometer.

Appendix 2 below describes an artificial mouth used by the Bell System in the United States of America.

The British Post Office has also developed an artificial mouth a description of which will be published later ; this artificial mouth has been used in the SFERT laboratory for studying the non-linear distortion of microphones.

2. For checking the efficiency of subscribers' apparatus in service an artificial mouth may be used which is not exactly in accordance with the above guiding principles. In particular :—

(*a*) Although it is desirable that the results obtained with such artificial mouth in periodical maintenance tests should agree as closely as possible with the results obtained with the human voice, it must be remembered that the most important conditions to be met in such a case are the following : lightness, simplicity, reliability and low cost.

(*b*) If the artificial mouth in periodical maintenance tests is used only to compare the microphone under test with a standard microphone of assured stability it is not essential that the acoustic field in front of the device should resemble as closely as possible that in front of the mouth of an operator.

The British Post Office, for periodical maintenance tests on subscribers' premises, uses a noise generator which is described in Appendix 3 below.

The German Administration on the other hand uses, for periodical maintenance tests, a smaller

model of the artificial voice described in Appendix 1 which takes the form of a pocket size metal box having an opening on one side of appropriate shape.

Note.—The Plenary Meeting at Copenhagen in 1936 was of the opinion that it was desirable to use special terms to designate on the one hand a source of artificial speech (gramophone record or mixture of pure sinusoidal sounds behaving in a similar manner to the human voice) and on the other hand an apparatus designed to produce a certain acoustic field fulfilling certain specified conditions and artificially simulating the human mouth. The term " artificial voice " is suitable in the first case and " artificial mouth " in the second.

APPENDIX 1.

The German Telephone Administration has made some investigations with an artificial mouth (Kunstlicher Mund) developed by Messrs. Siemens and Halske. This device satisfies the conditions laid down for an artificial mouth ; the sounds produced have constant equivalent loudness and a continuous acoustic spectrum, the characteristics of which are in close agreement with those of the acoustic spectrum of the human voice.

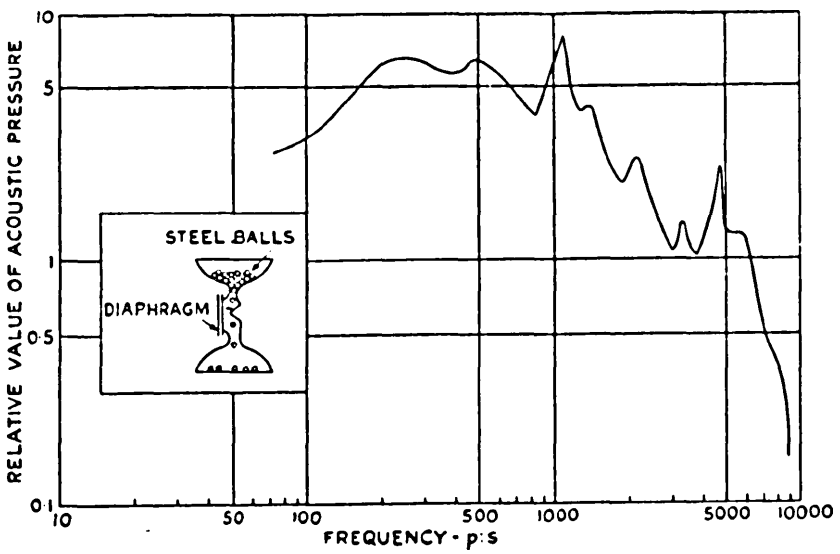
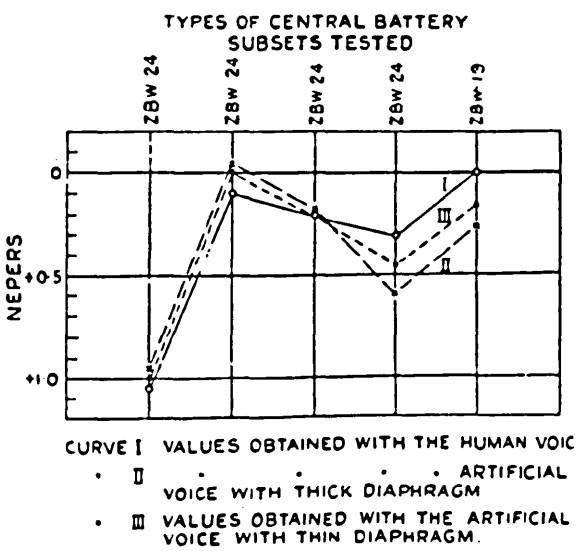


FIG. 1.

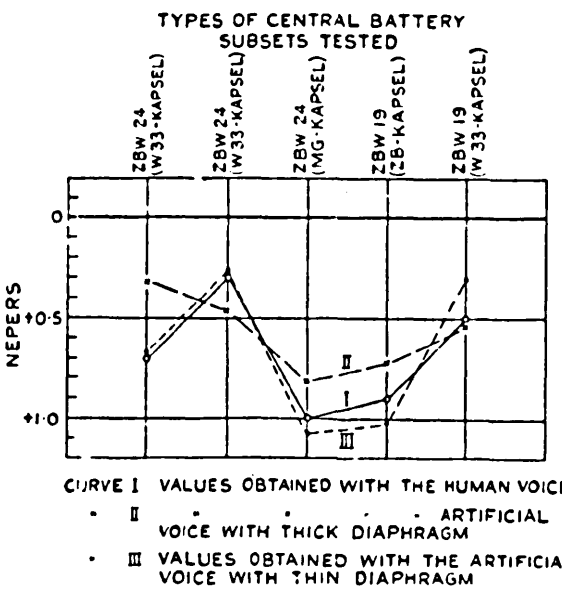


CURVE I VALUES OBTAINED WITH THE HUMAN VOICE

• II • • • • ARTIFICIAL VOICE WITH THICK DIAPHRAGM

• III VALUES OBTAINED WITH THE ARTIFICIAL VOICE WITH THIN DIAPHRAGM.

FIG. 2.



CURVE I VALUES OBTAINED WITH THE HUMAN VOICE.

• II • • • • ARTIFICIAL VOICE WITH THICK DIAPHRAGM

• III VALUES OBTAINED WITH THE ARTIFICIAL VOICE WITH THIN DIAPHRAGM

FIG. 3.

The device, a schematic of which appears as an inset in Fig. 1, resembles an hour-glass in construction. Steel balls from a container fall through an opening on to a rigid base which is at an angle of 45° from the vertical and placed behind a diaphragm. The balls are thrown off from this surface, striking the diaphragm in passing, and fall into another container. If the apparatus is constructed quite symmetrically so that, like an image in a mirror, there is a second rigid surface inclined at 45° from the vertical passing through its centre and another container below, it is obvious that on turning the apparatus upside down the cascade of balls will recommence. The duration of the fall of all the balls is determined by their number and the diameter of the opening through which they pass, whilst the equivalent loudness of the sounds produced is determined by the diameter of each ball and the height from which it falls. The characteristics of the diaphragm are mainly responsible for determining the acoustic spectrum. The continuity of the spectrum is ensured by the irregularity of the falling of the balls; when the balls have a diameter of 2 millimetres and the opening through which they fall a diameter of 8.5 millimetres, about 400 balls per second pass.

Measurements made with the reference system of the German Administration have shown good agreement between the values measured with the human voice and those measured with this artificial mouth. (See Figs. 2 and 3.)

APPENDIX 2.

DESCRIPTION OF THE ARTIFICIAL MOUTH USED BY THE BELL SYSTEM IN THE UNITED STATES OF AMERICA.

The schematic of the artificial mouth is shown in Fig. 1 below. As has been indicated above, the electrical energy applied to the electro-acoustic converter through the electric circuit and the amplifier may be supplied by any one of several sources of electrical energy. For measurements at one frequency only a heterodyne oscillator is a practical means of procuring the necessary test current. For a source of vocal sound, advantage may be taken of the recent phonographic progress, thanks to which it is now possible to record and reproduce the human voice almost without distortion.* This is a very satisfactory means of obtaining vocal sound to be used in the artificial voice. In certain special cases when it is desired to make measurements with the human voice under very severe conditions, a high quality microphone (transmitting system) is used at the input of the artificial mouth.

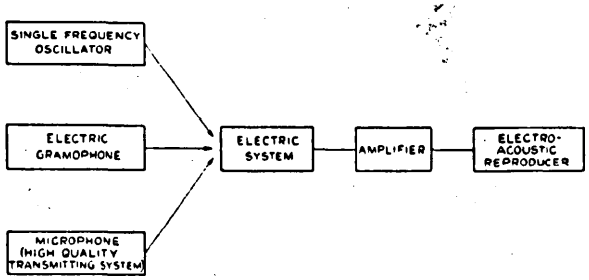


FIG. 1.

In order that the operation may be as satisfactory, both in steady state conditions and in transient conditions, the electrical circuit used in the artificial voice is of the constant resistance type.† This circuit corrects the irregularities of the characteristic curve of variation of amplitude with frequency, in the electro acoustic converter. An additional correction may be applied when it is desired to weight the various sinusoidal components of the wave emitted by the artificial mouth, with weights corresponding to the distribution in human speech‡ of acoustic pressure as a function of frequency.

* "Vertical sound records—Recent fundamental advances in mechanical records on wax." Paper read by H. A. Frederick at Swampscott (Mass.) in October 1931, before the Society of Cinematographic Engineers.

† "Distortion correction in electrical circuits with constant resistance recurrent networks," Otto J. Zobel, *Bell System Technical Journal*, July 1928.

‡ "Some physical characteristics of speech and music," Harvey Fletcher, *Bell System Technical Journal*, July 1931.

The amplifiers used give a high gain and are capable of a large output. Without introducing distortion, they provide the maximum quantity of electrical energy which may be required to permit the artificial mouth to give the acoustic power desired.

The device used as an artificial mouth is shown in Fig. 2 ; it is mounted on a support enabling it to be turned through 180° to facilitate certain measurements. It is a high-powered loud speaking

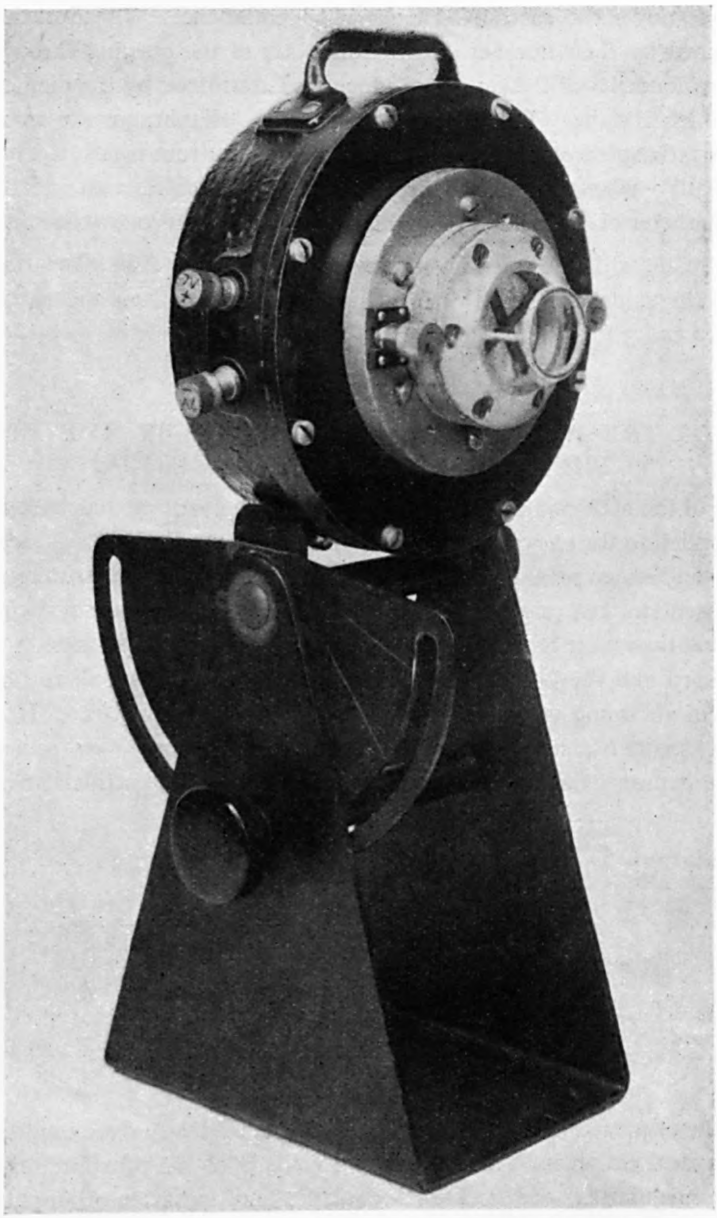


FIG. 2.

receiver, suitably modified.* A device for use in replacing the human mouth must, in particular, satisfy the following condition : the distribution of the acoustic field of the artificial mouth must be similar to that of the human mouth. It is necessary, therefore, that the orifice of the artificial mouth

* "A high efficiency receiver of large power capacity for horn type loud speakers," E. C. Wente and A. L. Thuras, *Bell System Technical Journal*, January 1928.

(from whence flow the acoustic waves) should have a surface comparable with that of the human mouth. For this purpose the horn generally used with this type of loud speaker is removed, and the orifice (or throat) of the receiver is modified. In place of the horn a device of simple form is fixed which has an opening effectively equal to that of the human mouth. In this framework is fixed an arrangement which introduces an acoustic resistance (a resistance of about 41 mechanical ohms per sq. cm), and below 5 000 p : s a reactance (acoustic) of less than 10 per cent. On the device is fixed a guard ring which serves as a point from which the measurement of the distance between the artificial mouth and the apparatus under test can be measured. The position of this reference point was determined in an empirical manner so that it corresponds to the position of the lips of a human mouth.

At low frequencies the radius of the orifice of the artificial mouth is small compared to the wave length. Hence, almost a point source of sound is obtained. Under these conditions the radiation resistance is small. When the frequency rises the radiation resistance increases until the wave length has decreased to a value approximately equal to three times the radius of the orifice. At this frequency and those above it, the radiation resistance is almost constant and of the order of 41 ohms per sq. cm. The output impedance (acoustic) of the artificial mouth is high compared to the radiation impedance at all frequencies. In a measurement where the impedances are not adapted to one another, except at the high frequencies, the power developed at the output of the artificial mouth is almost proportional to the radiation resistance. This proportion, nevertheless, is modified by the resonance of the apparatus. Acoustic resistance decreases this resonance ; it also attenuates the reaction which may be produced on the artificial mouth when an apparatus is placed directly in front of it.

Fig. 3 shows the characteristic curve of operation of the artificial mouth (at various frequencies) plotted from values measured from the guard ring. To maintain uniform operation throughout the very extensive band of voice frequencies (100-7 500 p : s) the characteristic curve of Fig. 3 is corrected by means of the electrical network shown in Fig. 1. The resultant curve, showing the operation of the artificial mouth at different frequencies is shown in Fig. 4.

Another important requirement is that the artificial mouth should be able to produce, without non-linear distortion, acoustic power similar to that produced by people speaking loudly. On account of the fact that it is desirable to operate at low frequencies (say 100 p : s) a relatively large amount of electrical energy must be applied to the artificial mouth. To do this an amplifier is used as shown in Fig. 1 ; thanks to this an acoustic pressure of 16 bars can be obtained in the plane of the guard ring at any frequency between 100 and 7 500 p : s without any appreciable harmonics. Under these conditions it is possible to transmit without appreciable distortion a speech power 15 decibels above the average speech power used in commercial telephone conversations. Very few conversations take place with a greater power than this.

Measurements have been made of the magnitude of the harmonics present at the output of the artificial voice under conditions of high acoustic pressure and at a frequency of 100 p : s at which the highest amplitude is obtained. Uneven harmonics only existed ; the most important (the 3rd harmonic) was about 15 decibels below the fundamental for the highest acoustic pressure used. At other frequencies or at lower acoustic pressures, the harmonics were even smaller. At the mean speech power used in telephone conversations, there were no appreciable harmonics. The results of these tests are shown in Fig. 5.

It has been specified that the distribution of the acoustic field must be the same both for the human mouth and the artificial mouth. To ensure that this is so, the power (at the output) of several microphones of different kinds has been measured, by placing these apparatus at varying distances from the artificial mouth and then from the human mouth. Eight persons (4 men and 4 women) took part in the telephonometric tests and spoke the special phrases " Joe took father's shoe bench out " and " she was waiting at my lawn." These two phrases include all the important vowels in the

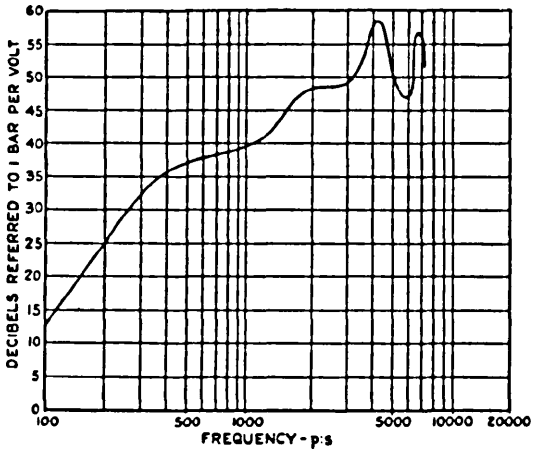


FIG. 3.

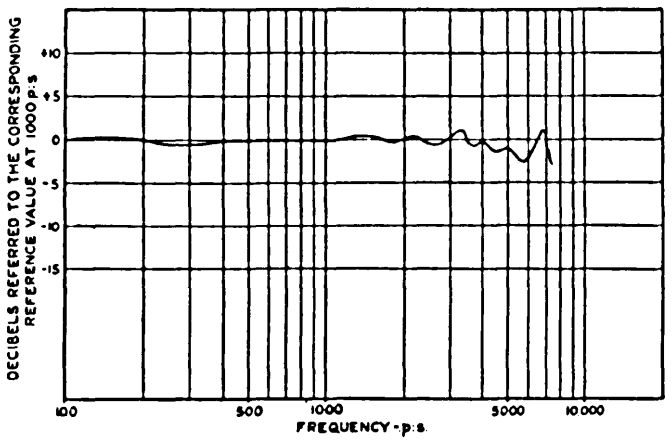


FIG. 4.

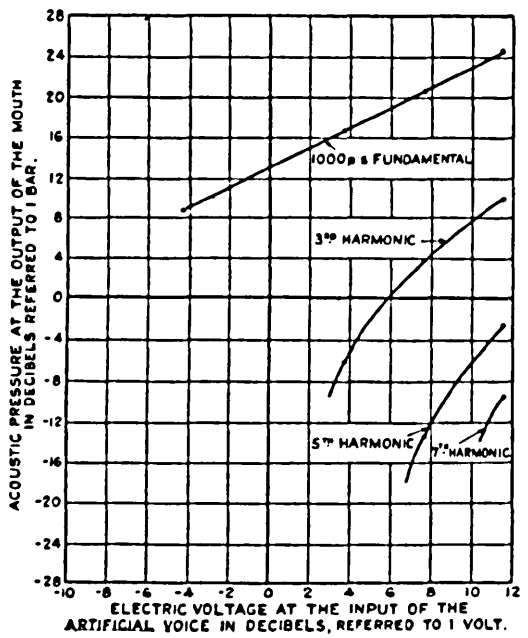


FIG. 5.

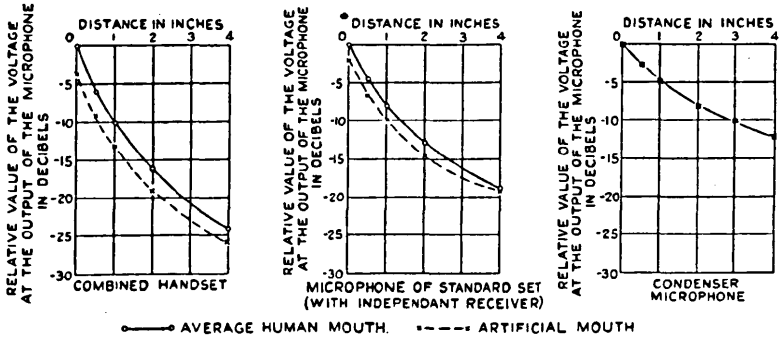


FIG. 6.

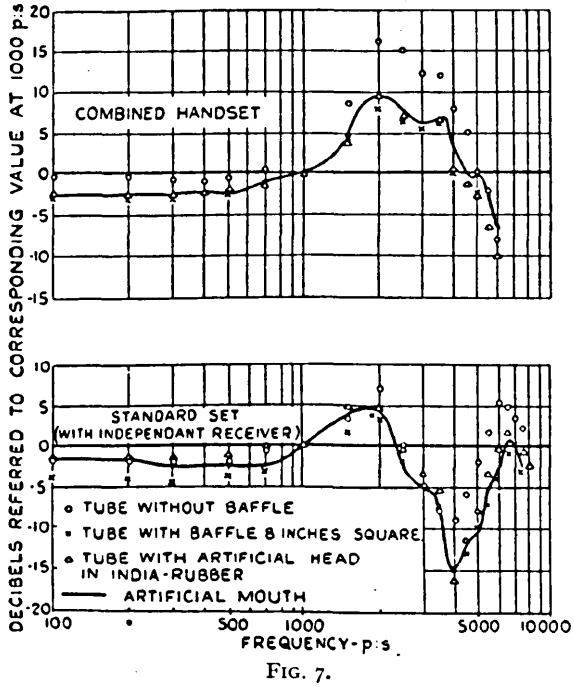


FIG. 7.

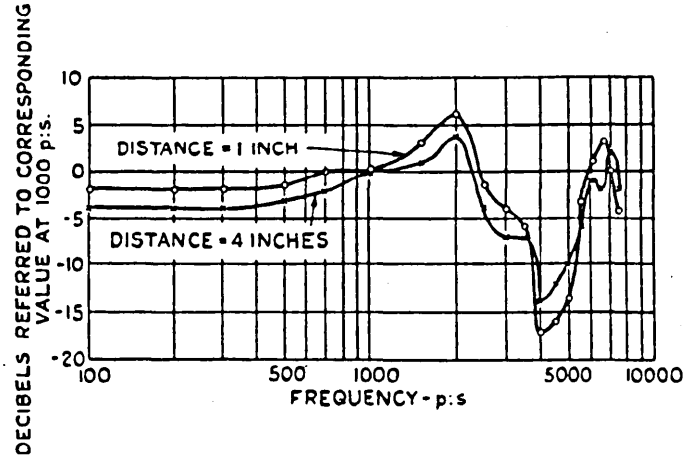


FIG. 8.

English language. They are short and easily pronounced. The speech of the eight persons in question when they spoke the above phrases was recorded by the procedure indicated above. After having adjusted the output of the artificial mouth to a value corresponding to that used in a conversation by means of a condenser microphone held close to the lips, tests were made alternating the various apparatus and the human voice in order to lessen the number of experimental errors and variations which might have appeared in the characteristics of the apparatus between two tests.

For an apparatus of any one type the differences between the various results obtained with the human mouth and those obtained with the artificial mouth are practically of the same order of magnitude. In Fig. 6 are shown the results (average values) of all the tests for each type of apparatus at each distance, both for the human mouth and the artificial mouth. These results show that a very satisfactory agreement exists between the artificial mouth and the human mouth, both from the point of view of the general level of the curves of variation in efficiency as a function of the distance and of the slope of the curves. In practice, when the artificial mouth is employed in the study of telephone apparatus, the small differences observed can be reduced to a minimum by means of suitable correction factors. A study is now in progress of the distribution of the acoustic field of the artificial mouth in comparison with that of human mouths.

Tests have been made to observe the effect upon telephone apparatus under test of the size and form of the artificial mouth. The electric voltage at various frequencies has been measured at the terminals of the microphone of a telephone set with separate receiver and of a hand microtelephone. In each of these telephone sets the normal carbon microphone was replaced by a small condenser microphone (placed in the plane occupied by the diaphragm of the carbon microphone). By this means all the causes of variation inherent in carbon microphones were avoided. The acoustic pressure acting on the microphone was provided successively by four different types of artificial mouths. Three of these included a long tube having an internal diameter of approximately seven-tenths of an inch (18 mm). In one there was no baffle nor any reflecting surface at the mouth of the tube. In the others the tube was terminated (1) by an india-rubber model of a human head, (2) by an 8-inch square baffle (1 inch = 0.0254 m). The fourth type of artificial mouth used was the acoustic resistance artificial mouth shown in Fig. 2. The variation of acoustic pressure measured under these various conditions is shown in Fig. 7. It will be noted that except in the extreme case of the tube with no termination of any sort a satisfactory agreement was observed between the various curves of operation at different frequencies, which shows that the form of the artificial mouth has no special importance, provided that the opening is of a suitable size, and is placed in a baffle comparable in size to the head of an adult. The measurements described above have been made giving the plane of the mouthpieces of the microphones a typical position with regard to the plane of the orifice of the artificial mouth. To ascertain the effect of increasing the distance between the microphone and the mouth, tests have been made with a fixed microphone type of set, the results of which are shown in Fig. 8.

For each of the four types of artificial mouth mentioned above the distortion of the acoustic field produced by introducing various microphones into it has been determined, experimentally. The effect was measured at the side of and in close proximity to the orifice. From Fig. 9 it may be seen that for frequencies below 2 000 p : s a satisfactory agreement was indicated for the various types of artificial mouth and for both types of telephone set. Above 2 000 p : s differences were shown but, generally speaking, the greatest differences occurred as before in the extreme case when the tube of the artificial mouth had no termination fitted.

To sum up the results obtained with the artificial mouth described above, it may be said that although the general conditions were not completely satisfied, an extremely good approximation was obtained. The operating characteristics at the various frequencies did not vary by more than $\pm$ 1 decibel for the frequency band 250—3 000 p : s, nor by more than $\pm$ 2 decibels between 100 and

7 500 p : s. The acoustic intensity produced without appreciable non-linear distortion by the artificial mouth is equal to that produced by a person speaking loudly. The distribution of the acoustic field is similar to that in the case of the human mouth. Judging from the results obtained by using artificial mouths of different size and form it appears that the introduction of objects into the acoustic field

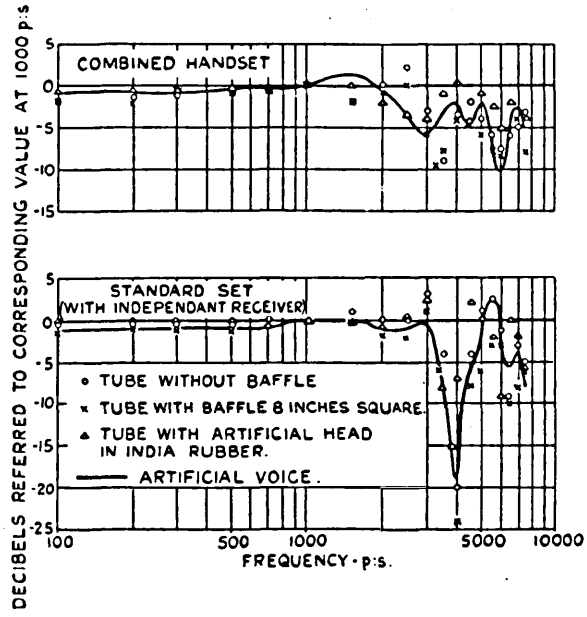


FIG. 9.

of the artificial mouth used distorts this field in a similar fashion to that of a human mouth. Speech reproduced by the artificial voice has a natural tone. Articulation tests made by means of an operator's voice and the artificial mouth give results which are identical within a few per cent. The device can be defined by specification and is capable of exact reproduction ; it is of sturdy construction and stable operation.

Experience obtained in the United States of America shows that the artificial mouth described above can be used successfully for measurements of microphones which have hitherto been carried out by means of the human voice.

APPENDIX 3.

ARTIFICIAL VOICE USED BY THE BRITISH POST OFFICE FOR ROUTINE MAINTENANCE TESTS AT THE SUBSCRIBER'S STATION.

(Article by Messrs. Barnes and Swift which appeared in the *Post Office Electrical Engineers' Journal*, October 1934, under the title of "A Transmission Test Set for Subscribers' Instruments, Local Lines, and Exchange Apparatus.")

Several attempts have been made in the past ten years to devise a means of testing the transmission efficiency of subscribers' instruments, including the microphone, by a simple test capable of being made quickly by the maintenance officer in conjunction with the telephone exchange test clerk. This article describes simple and inexpensive testing equipment with which subscribers' apparatus, including the local line and microphone may be tested in a routine manner.

The apparatus consists of three units, namely :—

(1) Noise Generator No. 1.

(2) Oscillator No. 8A.

(3) Tester T.L. 1635. (If mounted on a test desk—a Panel Test A.T. 2635.)

The Oscillator No. 8A and the Tester T.L. 1635 are portable units used for measuring the attenuation in lines or apparatus at 300, 800 or 2 000 c.p.s. The Noise Generator No. 1 and a modified form of the Tester T.L. 1635 may be used for obtaining the overall efficiency of a subscriber's circuit, including the transmitter, in terms of a standard circuit. A feature of both tests is that the results may be read on the meter of the Tester T.L. 1635 directly in decibels.

Testing of Subscribers' Instruments.

Three methods of measuring the efficiency of subscribers' instruments have previously been tried and it is thought a brief outline of the three methods will illustrate some of the difficulties that are met with.

(*a*) **The Artificial Cable Test.** In this test, which was used in telephone exchanges soon after the introduction of C.B. working, no quantitative measurements were made, but a listening test was made by an officer at the telephone exchange to a talk from a maintenance officer at the subscriber's telephone over a circuit consisting of the subscriber's line plus thirty miles of artificial cable. It will be realised that with this test the number of microphones described as faulty and changed will depend, amongst other factors, on the strength of the lineman's voice, the distance from the microphone at which he speaks, the acuteness of hearing of the listener, and the amount of extraneous noise in the test room where the listener is located.

(*b*) **The Subscriber's Station Efficiency Tester.*** An obvious step from the artificial cable test was to provide the listener with a measuring instrument and the talker with a standard microphone for comparison with the test microphone. Such an equipment has been used at Willesden Exchange with useful results. This equipment also provided for the quantitative testing of receivers and for this purpose included a high gain amplifier which increased the cost out of proportion to the advantages obtained from the receiver test.

(*c*) **The Palmers Green Test Set.** In this test set the receiver test was abandoned and a two-valve amplifier rectifier employed in conjunction with the test desk voltmeter for comparing the output from a standard microphone carried by the lineman and the subscriber's microphone. It will be apparent that this method of testing relies for its accuracy on the judgment of the lineman in talking with equal volume into and at the same distance from both the standard and the test microphones. There is the additional manipulative difficulty of connecting the standard microphone to the circuit.

The introduction of the Noise Generator No. 1 by the Research Section, Dollis Hill, and the commercial development of the sensitive copper oxide rectifier A.C. voltmeter enabled the present test set to be evolved. It surmounts the main difficulties present in previous test sets and makes possible for the first time the routine measurement of microphone efficiencies in the field, with known maximum errors.

General Requirements of a Suitable Test.

It is now the practice in the Post Office to design each subscriber's plant and line so that the transmission is up to a certain standard grade. The standard grade of transmission is that given by a standard Microtelephone No. 162 with a Bell Set No. 1, connected through a non-reactive line

* "Routine Transmission Testing of Subscribers' Instruments at the Subscriber's Office," A. Hudson, *P.O.E.E. Journal*, Vol. 21.

of 300 ohms, to a standard 22-volt C.B. cord circuit.* The distance of the average speaker from the microphone mouthpiece has been assessed from actual measurements and as this distance is different in the cases of pedestal and microtelephone type instruments, this difference is allowed for when estimating the efficiency of any circuit in terms of the standard circuit.

When the new basis of plant design has been in use for a sufficient period, we shall reach the condition where theoretically no subscriber's circuit, if the apparatus is in order, will have a worse efficiency than that of the standard circuit if the circuits were compared, by means of a speech test, with the talker speaking at constant volume, but at the correct average distance for the type of telephone. Any routine test of subscribers' circuits, therefore, should be capable of measuring its efficiency in terms of the standard circuit and of giving results in agreement with speech tests.

As a satisfactory test would be used by thousands of linemen any equipment to be used by them should be inexpensive, stable, robust, light and not complicated in operation.

Standard Noise and Voltmeter Test.

It will be noted that the previous methods of test described above have relied upon a lineman's judgment in talking correctly into the microphone under test. It is extremely difficult for a speaker, without much practice, to keep his voice constant during a test, and it has long been realised that a device emitting a suitable noise to replace speech is desirable both in acceptance and field tests of microphones. The Telephone Instrument Tester† has been used now for some years for acceptance tests and a noise generator suitable for use by linemen has been designed to provide a constant source of sound for field tests.

To provide the necessary measuring equipment at the exchange, it was decided to use, if possible, a 0-1 volt metal rectifier instrument without any amplifier since this type and range of meter was standardised for use with an attenuation measuring set for local lines. This instrument is described later in this article, and the use of a common meter will greatly facilitate the complete testing of equipment.

Noise Generator No. 1.

A photograph of the noise generator is shown in Fig. 1. The overall dimensions are $2\frac{13}{16}$ in. × $2\frac{13}{16}$ in. × $2\frac{1}{4}$ in. and the weight 1 lb. The apparatus is readily carried about and can be applied to the microphone under test with one hand.

In principle the generator consists of a light nickel silver cone rigidly clamped round the edge. The apex of the cone is fitted with a hard steel adjustable pip which is struck by a number of hard steel balls at irregularly spaced intervals. The balls are carried in slots in a wheel which is made to rotate by clockwork. The slots are not quite radial but are placed so that the balls which fly out to the edge of the wheel under centrifugal force, have the minimum restriction of movement on striking the cone ; the wear on both the cone and the balls will hence be a minimum. The balls are spaced irregularly round the wheel, the pitch varying from 15° to 26.5° ; in this manner the sound radiated by the cone during one revolution of the wheel consists of a varying fundamental frequency which, with the harmonics, covers the speech range. The wheel rotates at 300 revolutions per minute.

The mechanism of the generator is enclosed in a die-cast zinc alloy box from which it is insulated by rubber to prevent the mechanical transmission of vibration to the transmitter. The speed of the wheel is kept constant by a governor similar to the one fitted in automatic dials. The wheel, which is set in motion by the depression of a button, rotates for 8 seconds, giving ample time for the test.

---

* " Modern Developments in Telephone Transmission over Lines," J. Stratton and W. G. Luxton. A paper read before the London Centre of the I.P.O.E.E. on October 10th, 1933.

† " Mechanical Testing of Transmitter and Receiver Efficiencies," A. Hudson, *P.O.E.E. Journal*, Vol. 22.

The noise generator is intended to radiate sound, the intensity of which will remain constant during the life of the apparatus. All noise generators will be adjusted before being put into service to give the same volume of sound output. This adjustment is made by setting the speed to 300 revolutions per minute and varying the distance of the cone pip from the rotating ball wheel. The speed adjustment

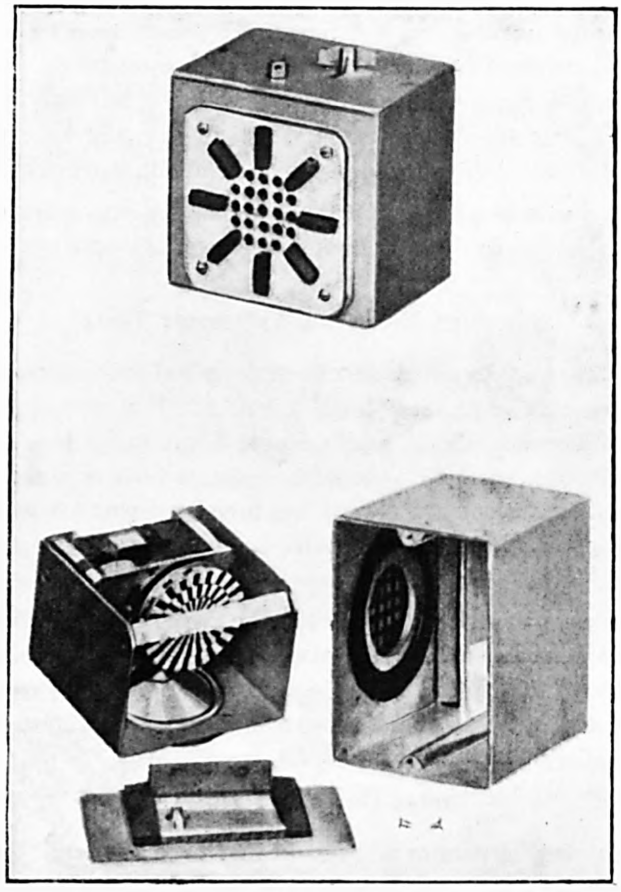


FIG. 1.

is facilitated by the use of a stroboscopic disc designed for use with a lamp on a 50-cycle per second supply.

The moulded rubber guard on the front of the case is designed to place the generator in the correct position relative to the microphones ; it is suitable for either the curved mouthpiece of the " Telephone No. 162 " or the flat mouthpiece of the " Transmitter No. 22 " or " Transmitter No. 1."

Noise generators manufactured under mass production conditions can readily be adjusted to give a maximum difference of plus or minus 0.7 db in sound output compared with a standard. There is no adjustment possible in regard to the natural frequency of vibration of the cone ; this, however, is not of great importance provided that departures from the standard are within defined limits. Actually cones are selected to a standard before assembly, but it is inevitable that small differences between cones will occur. These differences will not affect the accuracy beyond the 0.7 db. mentioned above.

Decibelmeter No. 1, Tester T.L. 1635 and Panel Test AT. 2635.

The common meter used at the receiving end for both noise generator tests of the efficiency of microphones and for single frequency measurements of attenuation, is a 0-1 volt A.C. meter incorporat-

ing a copper oxide rectifier. The impedance of the meter is 2 000 ohms at full scale deflection, but increases as the deflection decreases. The meter has been designed by instrument manufacturers primarily for this test and much research work has been done to provide an instrument with small temperature and frequency errors, with suitable damping and scale shape. The voltmeter measures the voltage across a non-reactive resistor of such a value that the impedance of the resistor-voltmeter combination is 600 ohms at full scale deflection. The resistor is attached to the meter case and the combination called a Decibelmeter No. 1. The decibelmeter has two ranges: 0-15 db and 5-20 db; each meter is calibrated individually in decibels by inserting known losses between an oscillator and the meter in order to allow for the change of impedance of the meter.

The decibelmeter, with a condenser and inductor, is mounted as a portable unit called a Tester T.L. 1635, for making single frequency tests in conjunction with an Oscillator 8A. For noise generator tests the decibelmeter is associated with a transmission bridge; the combination is mounted on a test desk and is called a Panel Test A.T. 2635. By means of a key, this test desk equipment may be made identical with a Tester T.L. 1635 and used for the same purpose.

The Minimum Permissible Noise Voltage at the Exchange.

In deciding the minimum permissible A.C. voltage at the exchange which should be produced by any type of microphone when excited by a noise generator, the following considerations require attention.

The magnitude of the sound pressure on the microphone diaphragm is important since the relative efficiency of two circuits will vary, depending on the volume of the sound used for testing; this effect will be particularly noticeable when one of the circuits is working C.B. and the other L.B. In order to be able to use a 0-1 volt instrument to measure the A.C. power at the exchange the volume of sound from the noise generator has been increased to a level of about 10 decibels above the level used by the average subscriber when making a trunk call; it is also at least 10 decibels above the volume used when making speech tests in the laboratory. It follows, therefore, that two circuits which have apparently the same efficiency when tested by speech may have different efficiencies when the noise generator test is applied. These differences are modified, however, because in practice a speaker talks at different distances from microtelephones and from microphones of the pedestal type, such as transmitters No. 22, and the noise generator is used at a common distance for microphones of all types. It is impossible, therefore, to state a single figure for the minimum A.C. voltage that should be obtained at the exchange with a noise generator test of this type in order that all circuits should not be worse than the efficiency of the standard circuit when measured by means of a speech test. The differences, however, can readily be allowed for and a suitable value found for the minimum received voltage for each condition.

Tests have shown that an individual noise generator test of efficiency may be plus or minus two decibels different from the true speech efficiency so that in order to avoid the rejection of microphones which are between 0 and 2 db better than standard, it is necessary to allow a tolerance of 2 db in practice. This means that microphones which are on the maximum length of line allowed will be rejected if they are 2 db worse than standard and may be rejected if they have an efficiency between 0 and 2 db worse than standard.

When considering the case of L.B. instruments there is the complication of the microphone battery. If the test were carried out when the batteries were in good condition, a circuit might pass the test, but the efficiency might fall below that of the standard circuit as the voltage of the battery falls to the limiting condition. It is necessary to ensure that the test is carried out when the batteries are in an average condition; and if the cells are renewed immediately prior to a transmission test the voltage of the battery is reduced during the test to that of the average battery by means of a shunt

resistor. On long C.B. lines where L.B. instruments are fitted, the plant is designed to give standard transmission when the cells have the minimum permissible voltage of 1 volt per cell. With L.B. instruments in L.B. areas, the transmission efficiency is permitted to fall 2 db. below that of the standard circuit as the voltage of the cells drops from that of the average battery (1.2 volts per cell) to the limiting condition of 1.0 volt per cell.

These factors have been taken into account in preparing the table of rejection figures shown in Fig. 2 for use at Avenue Exchange where transmission tests are now in progress.

Type of Circuit	Type of Telephone	Bell Set No.	Maximum reading on Decibel Meter
C.B.	Instruments fitted with Transmitters No. 1	1	5
	Instruments with Transmitters No. 22, or H.M.T. Instruments fitted with Insets No. 10		8
L.B.	Instruments fitted with Transmitters No. 2	21	9
	Instruments with Transmitters No. 22, or H.M.T. Instruments fitted with Insets No. 10		12
P.B.X. Operator's Circuit (using operator's induction coil)	Instruments fitted with Transmitters B.P. No. 5A.	—	10
	Telephones No. 184	—	8

FIG. 2.—Rejection figures prepared for trial at Avenue Exchange.

Method of Making Transmission Tests.

The test desk equipment necessary for transmission tests is a Panel Test A.T. 2635, a circuit diagram of which is shown in Fig. 3. The equipment consists of a Decibelmeter No. 1 connected to a transmission bridge, consisting of a two-winding inductor and a 1 μF condenser. The exchange battery is applied through a resistor to the windings of the coil; the value of the resistor is adjusted for each type of exchange to give the same line current as the normal exchange cord circuit connected to a subscriber's line. The attenuation of the transmission bridge is 0.8 db at 800 cycles per second, and so compares with the loss in the average cord circuit. The operation of a key connects the apparatus to one of two test cords; a second key changes the range of the meter and a third key disconnects the exchange battery, short-circuits the 1 μF condenser and prepares the equipment for use with an Oscillator No. 8A for making single frequency measurements.

To carry out a transmission test, the subscriber's instrument is connected via the local line and the test cord to the test panel. The lineman applies the noise generator to the transmitter and the test clerk determines whether the reading on the decibelmeter is above or below the appropriate maximum permissible reading for that type of instrument; if the reading is above, then the transmission is unsatisfactory and faulty apparatus must be sought.

Proposed method of testing where the parent exchange is not equipped with a test desk.

Where normal testing is done over junctions from a central exchange, the junctions are arranged to give a loop without intervening transmission bridges between the central exchange and the subscriber. In these cases the total resistance of the line between the subscriber's apparatus and the central exchange may be 1 400 ohms. The high transmission loss of such a circuit, where the transmitter feeding current is received from the central exchange, makes a transmission test with noise generator and decibelmeter impracticable.

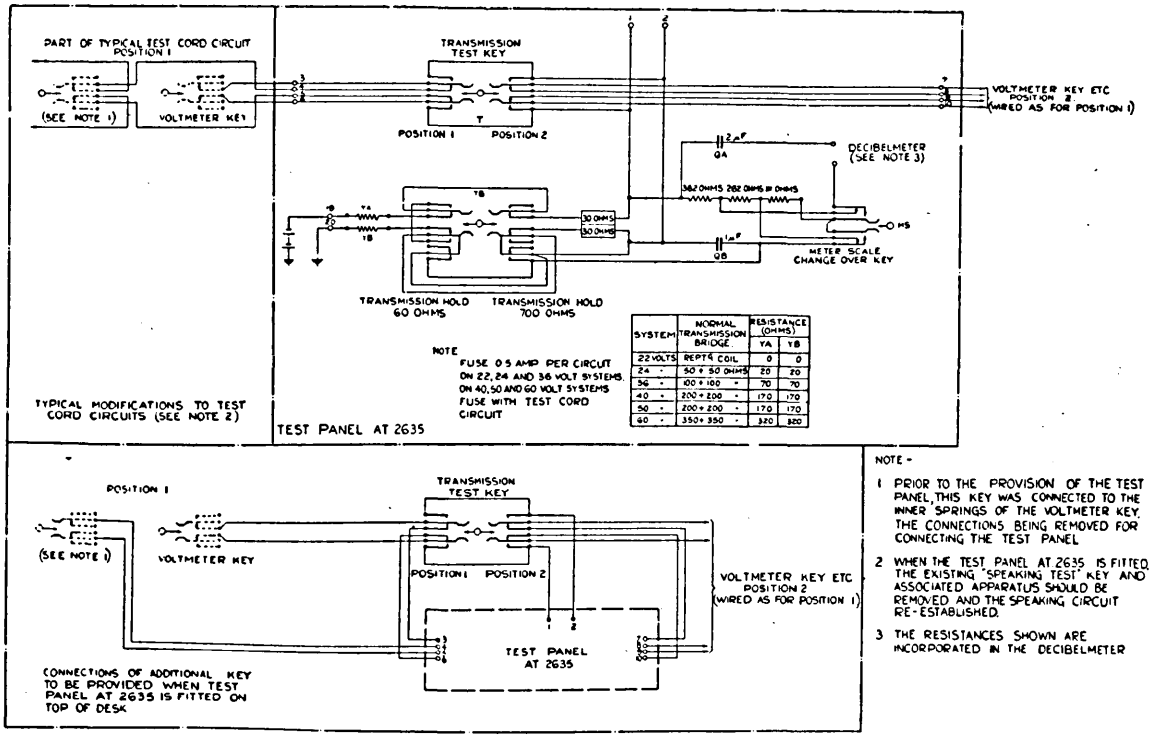


FIG. 3.

Alternative circuit arrangements which may be used are :—

(1) Extend the subscriber's circuit by an ordinary junction to the central exchange.

(2) Provide facilities for switching a transmission bridge into the test distributor junction at the local exchange ; the switching to be controlled at the central exchange.

Tests of the relative disadvantages of these two plans are in progress.

Proposed methods of measuring microphone efficiencies at remote stations.

There are a large number of subscribers, estimated at 200 000, served by about 4 800 exchanges where it is economically undesirable and in many cases technically impracticable to install decibelmeters for the purpose of making transmission tests from subscribers' premises.

Alternative methods of test are :—

(1) Provide the lineman with a measuring instrument, a Tester T.L. 1635 may be suitable, and measure the output from the subscriber's instrument at the instrument terminals.

(2) Extend the subscriber's circuit over a junction of known attenuation to the nearest exchange with transmission testing equipment.

Tests are in progress to determine the most suitable form of test.

Measurement of Attenuation in Lines and Apparatus.

In 1925 a junction test set was designed in the Research Section for measuring losses in lines up to 20 standard miles. The sending end consisted of a single valve oscillator giving a testing current at 800 cycles per second ; the receiving end was a two-valve amplifier rectifier. The test set had the disadvantages of requiring an individual battery to supply the anode current and a calibration chart to show the relation between the meter reading and the loss in standard miles.

Portable, direct reading equipment, consisting of an Oscillator No. 8A and a Tester T.L. 1635. has been designed to measure attenuations up to 20 decibels. The circuit diagram of the new set is shown in Fig. 4.

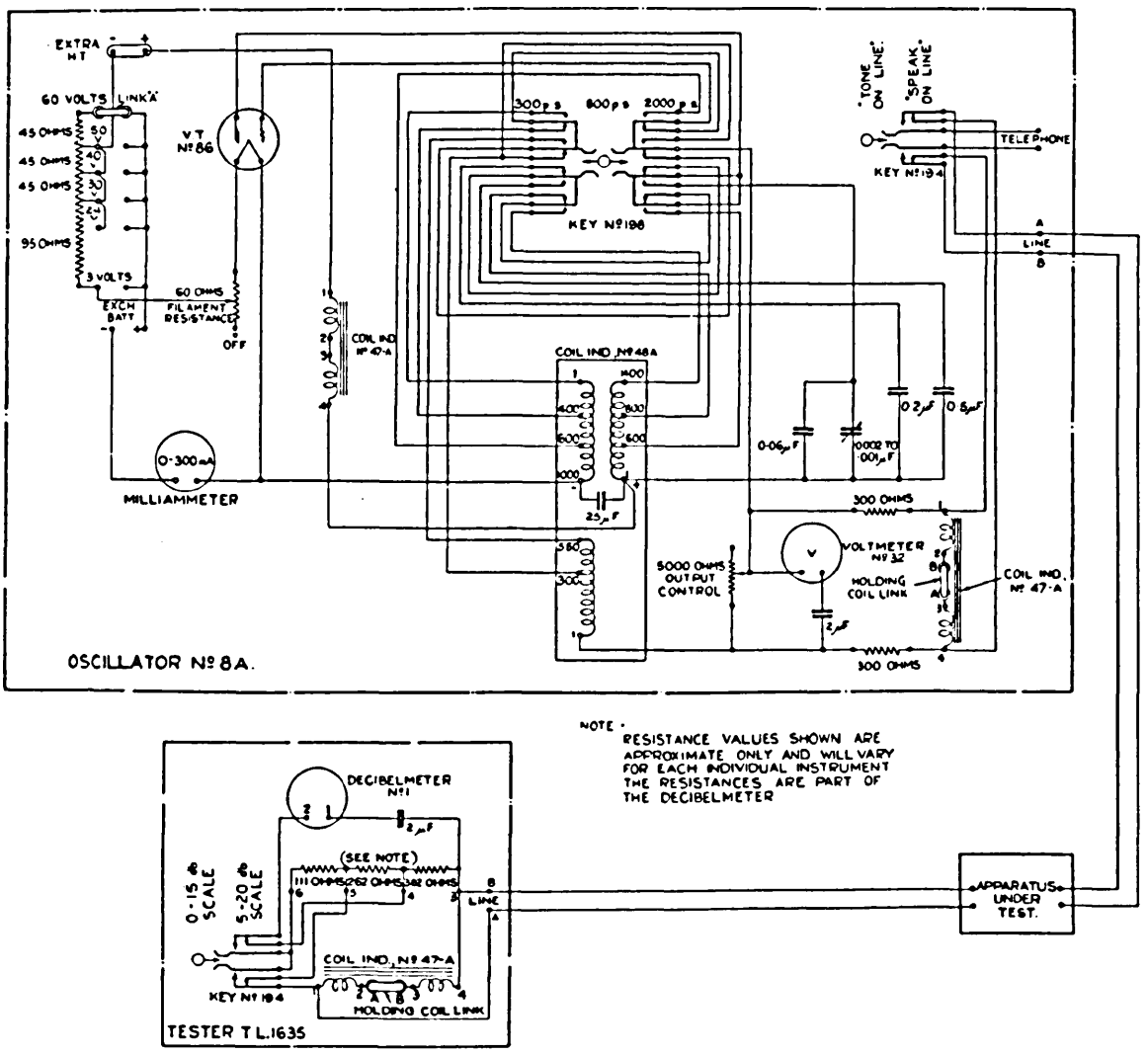


FIG. 4.

The oscillator has a single valve and is designed to work from any exchange battery from 25 volts to 60 volts. When a 22-volt battery only is available, two or three additional dry cells may be used to enable sufficient output to be obtained. Three frequencies are available, namely, 300, 800 and 2 000 cycles per second correct under all working conditions within plus or minus 10 per cent. Any one of these frequencies can be selected by throwing a key. The voltage output from the oscillator is measured by means of a 0-6 volt metal rectifier voltmeter.

The oscillator is designed to give at least 3.6 volts across a non-reactive output load of 800 ohms, of which 600 ohms is included in the oscillator in series with the output, so that at least 3.6 volts is measured on the meter with an external load of 200 ohms.

If the tester T.L. 1635 is connected to the oscillator with intervening apparatus giving a loss of 5 db when terminated with 600 ohms, the decibelmeter registers 1 volt (full scale deflection) when the oscillator is adjusted to 3.56 volts. This gives a voltage of 1.78 volt on the line terminals of the

oscillator, which is 5 db above the 1 volt required to give full scale on the decibelmeter of the receiving end. The testing power of 1 milliwatt used for repeatered lines would not give sufficient power through 20 db to operate the most sensitive rectifier voltmeter satisfactorily.

Both the oscillator and the tester T.L. 1635 are provided with inductors which have negligible A.C. loss but provide low D.C. resistance terminations where it is necessary, as in exchange cord circuits, to make measurements with large direct current in the apparatus under test in order to obtain the worst conditions which occur in practice. The inductors may be used also to provide a means of applying the exchange battery to the apparatus under test where this is necessary to operate the apparatus.

The Panel Test A.T. 2635 used by the test clerk for noise generator tests may also be used in conjunction with the oscillator for making tests over lines and apparatus at 300, 800 or 2 000 cycles per second. This should prove a most convenient and useful method or testing.

Conclusions.

The apparatus described above provides an accurate and inexpensive means of analysing the losses in subscribers' apparatus, local lines and unrepeatered junctions. A measurement of the attenuation of a circuit, particularly at a number of frequencies, often provides the quickest means of locating an obscure fault. This test set which enables apparatus to be so tested in a routine manner should prove of great value in the maintenance of telephone exchange apparatus and line plant. The noise generator test of subscribers' lines plus apparatus, whilst being inevitably subject to certain errors, should provide a valuable means of checking the efficiency of such circuits and provide a quick test in cases of transmission complaints.

PAGES 500-508.

Replace the present text under " <u>*Sound Meters*</u> *" by the following :—*

SOUND METERS. APPARATUS FOR THE OBJECTIVE MEASUREMENT OF ROOM NOISE.

The International Telephone Consultative Committee—

Considering :—

That all apparatus hitherto produced for the objective measurement of room noise have a certain number of features in common (the essential characteristics of two existing types are given in appendices I and II). Common features are : a microphone, an amplifier with filter circuit, a detector and an indicating apparatus of which the dynamic characteristics are similar to those recommended by the C.C.I.F. for volume indicators (see above).

That considerable differences still exist between the various types of apparatus, especially as to reference zero and the number of characteristic curves to be used in the measurement (these being always curves of equal loudness).

That it has not been possible hitherto to specify exactly all the essential characteristics for apparatus for measuring room noise.

Considering also,

That published information concerning the work of various national committees on standardisation or research is available which permits a useful comparison between these investigations to be made (see the bibliography in Appendix 3 below).

That these questions are now under study by the International Electrotechnical Committee.

Unanimously recommends :—

That it is desirable that the International Electrotechnical Committee should study the question of standardisation of the essential characteristics of sound meters (apparatus for the objective measurement of room noise) and should obtain as soon as possible an international agreement on the subject. For its own part the C.C.I.F. will continue its study of the question and will advise the International Electrotechnical Committee of the results.

The International Telephone Consultative Committee—

Considering further :—

That apparatus for the measurement of room noise hitherto constructed are not designed to measure exactly sounds of very short duration but are of the greatest use in measuring the noise met with in locations where telephone apparatus is generally installed,

That it is possible, nevertheless, to get an idea of the magnitude of sounds of short duration by watching the displacement of the needle of the instrument in a similar manner to that in which the ear observes the force of a rapidly varying sound.

Unanimously recommends :—

That it is not yet possible to specify in detail the method of measuring room noise of rapidly varying intensity.

That it is advisable that the study of this question should be continued by the various Administrations and Operating Companies and that, therefore, the study of question 18a in its present form should be continued.

Note.—In the course of experiments carried out by Messrs. Siemens & Halske with experienced operators, it has been noted that there was not any great difference between the results obtained by objective and subjective measurements.

On the other hand, numerous tests show that in subjective measurements the results obtained by the same partially trained operator may vary by ± 7 decibels from the mean.

In consequence for this kind of measurement it is advisable to use fully trained operators and to check their efficiency regularly.

APPENDIX I.

ESSENTIAL CHARACTERISTICS OF THE APPARATUS FOR THE OBJECTIVE MEASUREMENT OF ROOM NOISE USED BY THE GERMAN ADMINISTRATION.

Scale—in phons.

Operating characteristics at different frequencies—The curves of the filter circuits must be chosen in such a way that in switching from one curve to another, that is from one sensitivity of the sound meter to another, differences as small as possible are incurred both at high and low frequencies.

Calibration—The first calibration of the sound meter should, in principle, be carried out in a free acoustic field. The readings of the measuring instrument correspond to the pressure of the freely propagated wave when the acoustic field is free from distortion. To avoid serious distortion of the acoustic field, maximum limits should be fixed for the microphone dimensions and especially for the dimensions of its main section. For the present the directional characteristics of the microphone are disregarded

The routine calibration of the sound meter which should, if possible, be carried out before each series of measurements is made acoustically in order to take into account variations of the microphone. For this purpose a mechanical device (normalschallgeber), producing a reference sound, may be used.

The accuracy of measurement for a sound of 1 000 p : s is ± 1 phon for all the sensitivity ranges of the sound meter. It is also necessary to obtain a constancy of approximately ± 1 phon for the mechanical device giving the reference sound. The maximum difference between the curves of the filter circuits with reference to the nominal curves which are still to be determined is ± 2.5 phons at the mean frequencies.

Reference Zero.—The zero is determined by the fact that a sinusoidal sound at 1 000 p : s, producing an acoustic pressure of an effective value of 1 microbar (1 dyne per sq. cm), must give a reading of 70 phons, a variation of 20 phons, corresponding to a 1 to 10 ratio of pressure.

Summation Law of the Noise Components.—Provisionally the quadratic law must be used, even for noise the maximum pressure of which is three times the acoustic pressure of a sinusoidal sound at 1 000 p : s producing the same subjective acoustic intensity.

Dynamic Characteristics.—The measuring instrument must have attained to within 20 per cent. of its final deviation after 0.2 second.

APPENDIX II.

ESSENTIAL CHARACTERISTICS OF THE APPARATUS FOR THE OBJECTIVE MEASUREMENT OF ROOM NOISE USED BY THE AMERICAN TELEPHONE & TELEGRAPH COMPANY (CONFORMING TO THE SPECIFICATION PROPOSED BY THE TECHNICAL COMMITTEE ON NOISE METERS AND NOISE LEVELS, OF THE AMERICAN STANDARD ASSOCIATION).

Scale.—A sound meter must have its scale in decibels. The magnitude measured by a sound meter is called the " sound level." For instance, a reading of 60 decibels on the sound meter will be called " 60 decibel sound level."

Operating Characteristics at Various Frequencies.—The operating characteristic of a sound meter at various frequencies in the case of progressive free waves must be that shown in Fig. 1* by curve A when one characteristic only exists. Where there are several characteristics of this kind use can be made either of Curve B in Fig. 1, of a flat characteristic, or both in addition to the characteristic shown in Curve A. Curves A and B are curves of equal loudness corresponding to sound levels of 40 and 70 decibels respectively, each being modified to take into account the differences between the individual and the normal threshold of audibility in a free acoustic field.†

When the results of sound meter measurements of subjective acoustic intensity are quoted the operating characteristic at the various frequencies used must always be given.

The tolerances admitted on the specified operating characteristics at various frequencies are shown by the dotted curves in Fig. 1. The tolerances on a flat operating characteristic would be the same as those shown for operating curves A and B. To determine whether the tolerances have been exceeded the method described in Appendix 3 should be followed. The frequency characteristic of a sound meter should lie within the tolerances for any gain adjustment with which that frequency characteristic is to be used.

The reading of the sound meter at a given frequency in a free acoustic field must be the mean of the readings made with progressive free waves having angles of incidence up to 90° from the normal

* English Edition 1934, page 501.

† See " Proposed standards for noise measurements," *Journal of the Acoustical Society of America*, Volume V, No. 2, October, 1933, page 110, figure 1, a French translation of which forms the second part of document " C.C.I.F. 1934, 9 4° C.R.—Document No. 32."

See also " On minimum audible sound fields," by L. J. Sivian and S. D. White, *Journal of the Acoustical Society of America*, Volume IV, No. 4, April, 1934.

supposing any angle of incidence within this area as equally probable. The method of taking this average is described in Annexe 1 to this Appendix II.

The difference between the reading of normal incidence and the reading for any other incidence must not exceed 5 decibels at any frequency below 1 000 p : s and 20 decibels at any frequency from 1 000 to 3 000 p : s.

Reference Point.—The reference point of the decibel scale used in sound meters is the reference acoustic intensity (10-16 watts per sq. cm at 1 000 p : s, progressive free wave).

Note.—Some difference generally exists between the normal frequency characteristic and that of any one sound meter. In order that, after the first calibration, the same reading may be obtained on all sound meters (whose operating characteristics at various frequencies vary in different ways from the nominal characteristic for any general kind of noise), the method of procedure given in Annexe 3 to this Appendix must be followed.

Summation Law for the Various Noise Components.—The characteristic of the sound meter must be such that it indicates the sum of the acoustic intensities of progressive free waves at 1 000 p : s which are equivalent to the different sinusoidal components of the complex acoustic wave measured ; in other words, the power indicated in the case of a complex acoustic wave must be the sum of the powers which would be indicated for each of its component frequencies taken separately.

Note.—In most sound meters this rule will not be exactly applicable for all types of waves. The tolerances in regard to the law of direct summation of weighted powers, as well as the tests for determining these differences are given in Annexe 2 below.

Dynamic Characteristic of the Indicating Instrument.—The dynamic characteristic of the indicating instrument of the sound meter must be such as to permit of the whole apparatus having the following dynamic characteristics.

(*a*) The needle deflection for a constant sinusoidal voltage at 1 000 p : s at the input of the sound meter must equal the maximum deflection of the needle for an impulse at 1 000 p : s of the same magnitude as the constant voltage and having a duration of between 0.2 and 0.25 second.

(*b*) The deflection of the needle for a constant sinusoidal voltage at 1 000 p : s at the input of the sound meter must not be exceeded by more than 1.0 decibel by the maximum swing of the needle at the sudden application of this constant voltage.

(*c*) The deflection of the needle for a constant sinusoidal voltage at 1 000 p : s at the input of the sound meter must be at least 1 decibel higher than the maximum deflection obtained by an impulse at 1 000 p : s of the same magnitude as the constant voltage and having a duration of 0.1 second.

These dynamic characteristics must be satisfied at all parts of the scale of the instrument.

When it is not desired to observe rapid fluctuations of equivalent loudness it is possible to use a slower acting indicating instrument in place of the instrument described above, in order to obtain the mean result. Readings obtained on this instrument must, however, agree with those made on the quick acting instrument in the case of sustained sounds.

ANNEX 1 TO APPENDIX II.

OPERATING CHARACTERISTICS OF SOUND METERS AT VARIOUS FREQUENCIES.

When a microphone forming part of a sound meter behaves differently for acoustic waves arriving at different angles of incidence, the sound meter reading will depend upon the direction of the acoustic wave to the measuring set. In more or less diffused acoustic fields, sound meters having microphones with different direction characteristics will give different readings even if they have previously been adjusted to give equal readings in the same acoustic field of normal incidence.

These differences may be reduced as much as possible :—

(*a*) By limiting the maximum difference between the operation at normal incidence and that for any other angle of incidence, and

(*b*) By using for the specification of the operating characteristic of the sound meter at various frequencies a method which takes into account the probable angles of incidence of the more important components of the sound. The maximum admissible tolerances for the nominal operating characteristic, as well as a method for specifying the nominal operating characteristic of the complete sound meter in a free acoustic field are given above. The following paragraphs give details of the method of determining the operating characteristic of a sound meter.

The operating characteristic of a sound meter in a free acoustic field as defined above can be deduced from readings obtained with acoustic waves falling on the microphone at various angles of incidence from within a certain specified area. The computation consists in taking the mean of the voltages at the output terminals of the microphone corresponding to plane waves of a given frequency arriving successively from all directions (within the specified area) assuming that all these directions are equally probable. Since in general the voltage variation at the terminals of the microphone as a function of the angle of incidence is not easily expressed mathematically, it will be more convenient to proceed by finite steps in the evaluation of the averages. It has been found that the following expression gives satisfactory results with electro dynamic or condenser microphones.

(1) $P = 0.034\,P_0 + 0.259\,P_{30} + 0.448\,P_{60} + 0.259\,P_{90}$

Where P = average total power from the microphone.

P_0 = power in the case of a wave of normal incidence.

P_{30} = power in the case of a wave making an angle of 30° with the normal.

P_{60} = power in the case of a wave making an angle of 60° with the normal.

P_{90} = power in the case of a wave making an angle of 90° with the normal.

As an example of the use of this expression, assume that by measuring the power from the microphone for progressive free waves of an incidence of 0°, 30°, 60° and 90° compared to the normal incidence the following is obtained :—

Frequency	Angle of Incidence	Electric power measured at the output of the microphone, corresponding to an intensity of 60 decibels above the reference acoustic intensity for the progressive free wave applied to the microphone.
4 000 p : s	0°	3.00 micro-micro watts
	30°	1.9 " " "
	60°	0.75 " " "
	90°	0.38 " " "

Substituting these values in formula (1) we get :—

(1) $P = (0.034 \times 3) + (0.259 \times 1.9) + (0.448 \times 0.75) + (0.259 \times 0.38) = 1.03$.

Thus the mean electric power at the output of the microphone at 4 000 p : s for an acoustic wave 60 decibels above the reference acoustic intensity is 1.03 micro-micro watt. (This is $1.03/3 = 0.34$ of the output power of the microphone for a wave of normal incidence so that the difference from the ordinate of the nominal operating characteristic of the sound meter as defined above for a free acoustic wave at 4 000 p : s at normal incidence is $10 \log_{10} 0.35 = -4.6$ decibels.)

Formula (1) was obtained as follows :—

Assume that the microphone is symmetrical about an axis normal to the plane of the diaphragm so that the power output of the microphone is constant for acoustic waves for which the direction of

incidence makes the same angle x with this axis. Assume further to a first approximation that the power is constant and equal to P_0 for all values of x between 0° and 15°, that for all values of x between 15° and 45° it is equal to the constant value P_{30} and so on.

Imagine a hemisphere and a cone having its axis normal to the great circle of the hemisphere and its apex at the centre and having an angle at the apex of $2 \times 15°$. Since all directions of incidence of the waves contained in the hemisphere are equally probable, the probability of any one wave falling at an angle of incidence for which x is between 0 and 15° is the ratio of the area of the hemisphere cut by the cone, to the total area of the hemisphere, which is found to be 0.034. It follows that the contribution to the power of the output by the waves whose directions of incidence lie within the cone is $0.034\ P_0$. Similarly the contribution made by the waves whose directions of incidence are contained between this cone and a cone of which the angle at the apex is $2 \times 45°$ is $0.259\ P_{30}$, and so on. The total output power of the microphone is the sum of the contributions made by each of these wave groups which gives us Formula (1).

If the hypothesis of the symmetry of action around the axis normal to the plane of the diaphragm of the microphone is not admissible it would be necessary to make a certain number of measurements each corresponding to a certain area of the hemisphere in front of the microphone. The mean of the powers obtained in this way compared to the power given by the reading for normal incidence to the diaphragm, would give a method of determining the nominal operating characteristic of the whole sound meter in a free acoustic field as defined above, provided that all the areas for which readings were obtained were about equal in size.

ANNEX 2 TO APPENDIX II.

TESTS CONCERNING THE SUMMATION OF POWERS.

To make these tests the procedure is as follows :—

First of all the set-up must be arranged so that two sinusoidal waves of different frequency (without appreciable harmonics) can be applied simultaneously to the sound meter, their magnitude being adjustable independently of one another. These waves must be purely sinusoidal and, theoretically, they should be acoustic waves although if it is preferred on account of the distortion caused by loud-speakers and receivers, electric sinusoidal waves can be applied to the sound meter at the output of the microphone.

The frequencies of these two sinusoidal waves should not be in simple relation, and they should be sufficiently far apart to avoid the indicating instrument following the interference beats. By choosing frequencies above 800 p : s the effect of the harmonics of the oscillator are more easily made negligible. The magnitude of each wave should be adjusted so that a mid-scale reading is obtained on the indicating instrument. The impedance relationship between the source of one sinusoidal wave, the input of the sound meter and the source of the second sinusoidal wave when one only of these waves is adjusted, must be identical to all the relationships encountered when both waves are applied simultaneously to the input of the sound meter. When the magnitude of one of these sinusoidal waves is adjusted the other must not in any way contribute to the deviation of the needle of the indicating instrument of the sound meter even though the impedance ratio remains the same as specified above. When each sinusoidal wave has been so adjusted that by itself it produces a mid-scale deflection both waves are applied simultaneously to the sound meter and both are attenuated in the same fashion until the mid-scale deflection is again obtained. This attenuation must be equal to 3 ± 0.5 decibels.

This experiment must be repeated for other portions of the scale until the whole range has been covered.

Among the sounds which one may be called upon to measure with a sound meter are complex waves and sounds so short in duration that the needle of the indicating instrument of the sound meter will not follow them. For such sounds the summation law for the powers of the rectifier must extend slightly beyond the normal interval in use when a whole scale deviation is produced by a sinusoidal wave. At the same time the amplifier must be of large dimensions to cover these points. As a result it is necessary to make tests to ensure that the characteristics of the amplifier and the rectifier are such that the summation law for the powers still holds good between certain limits for this type of sound. In order to determine whether the sound meter is suitable for this the following test should be carried out :—

Insert a resistance network between the terminals of the indicating instrument and the terminals to which the latter is normally connected, so that the same resistance as before is presented to the rectifier but in such a way that for a given power applied to the rectifier less current passes through the indicating instrument than before. This resistance network should cause a variation of some 7 or 8 decibels in the reading of the indicating instrument.

In the manner indicated above, arrange the set-up so that two sinusoidal waves (of different frequency but not in simple relationship and sufficiently far apart for the indicating instrument not to follow the beats) are applied simultaneously to the sound meter and adjusted in magnitude at the same time but independently of one another. Without the resistance network, adjust the magnitude of each wave so that a complete scale deflection is produced on the indicating instrument for each. Insert the resistance network and increase the magnitude of each wave by about 3 decibels. Note the deflection for each wave separately (both deflections should be the same). Then apply the two sinusoidal waves together and attenuate each equally until the same deflection is again obtained. The attenuation required should be 3 ± 1 decibels.

Repeat the experiment but after inserting the resistance network increase the magnitude of each wave by 6 decibels in place of 3. Note the deflection for each wave (which should be the same in each case) and then apply both waves simultaneously, attenuating them equally until the deflection obtained for each wave by itself is again obtained. In this case the attenuation should be 3 ± 1.5 decibels.

These limits should hold good for all positions of the calibrating and gain controls.

ANNEX 3 TO APPENDIX II.

COMPARISON OF THE OPERATING CHARACTERISTICS (AT VARIOUS FREQUENCIES) OF INDIVIDUAL SOUND METERS WITH THE NOMINAL CHARACTERISTIC.

The object of a comparison between the operating characteristic of a given sound meter at various frequencies and the nominal characteristic specified for sound meters is :—

(*a*) To determine whether the operating characteristic of any one sound meter falls within the prescribed tolerances, and

(*b*) To permit the calibration of a particular sound meter so that for a given general type of noise the reading given by this particular sound meter is almost identical with that obtained by a standard sound meter. The method consists in evaluating, for a medium noise, the weighted power at the output (1) of a standard sound meter and (2) of this particular sound meter. These output powers can be made equal by suitable adjustment of the given sound meter during its calibration. After this adjustment its operating characteristic at various frequencies must be compared to the nominal operating characteristic in order to determine whether it falls at the various frequencies within the prescribed

tolerances. The following example gives details of this method of comparison and also shows the mean relative value (in decibels) of the acoustic powers contained in the elementary bands of 100 p : s into which the acoustic spectrum of a noise of general character was divided during its analysis. It is this typical distribution of energy as a function of frequency which must be used in the calculations in the comparison of a normal with a particular sound meter. In order to make this comparison the only additional information which is necessary is the operating characteristic of the given sound meter with steady sinusoidal waves.

Since it is obvious that the total power would not be greatly affected by frequencies over 3 000 p : s the summation is intentionally stopped at this frequency.

Frequency in p : s. (1)	Relative acoustic power (in decibels) in the elementary bands of 100 p : s into which the acoustic spectrum of a noise of general type is divided. (2)	Weight in decibels (ordinates of the nominal operating characteristic of a normal sound meter at various frequencies). (3)	Sum (2) + (3) (4)	Corresponding Weighted Power (5)
100	+ 9.7	− 19.0	− 9.3	0.12
200	+ 8.2	− 11.0	− 2.8	0.52
300	+ 6.9	− 7.0	− 0.1	0.98
400	+ 5.7	− 5.0	+ 0.7	1.17
500	+ 4.5	− 3.5	+ 1.0	1.26
600	+ 3.4	− 2.5	+ 0.9	1.23
700	+ 2.3	− 1.7	+ 0.6	1.15
800	+ 1.5	− 1.0	+ 0.5	1.12
900	+ 0.7	− 0.4	+ 0.3	1.07
1 000	0	0	0	1.00
1 100	− 0.8	+ 0.5	− 0.3	0.93
1 200	− 1.5	+ 1.0	− 0.5	0.89
1 300	− 2.3	+ 1.2	− 1.1	0.78
1 400	− 2.9	+ 1.4	− 1.5	0.71
1 500	− 3.6	+ 1.6	− 2.0	0.63
1 600	− 4.2	+ 1.9	− 2.3	0.59
1 700	− 4.9	+ 2.0	− 2.9	0.51
1 800	− 5.5	+ 2.1	− 3.4	0.46
1 900	− 6.2	+ 2.3	− 3.9	0.41
2 000	− 6.8	+ 2.5	− 4.3	0.37
2 100	− 7.5	+ 2.7	− 4.8	0.33
2 200	− 8.1	+ 2.9	− 5.2	0.30
2 300	− 8.7	+ 3.0	− 5.7	0.27
2 400	− 9.3	+ 3.0	− 6.3	0.23
2 500	− 9.8	+ 3.1	− 6.7	0.21
2 600	− 10.3	+ 3.1	− 7.2	0.19
2 700	− 11.0	+ 3.1	− 7.9	0.16
2 800	− 11.5	+ 3.0	− 8.5	0.14
2 900	− 12.0	+ 3.0	− 9.0	0.13
3 000	− 12.5	+ 3.0	− 9.5	0.11
Sum of the weighted powers for the standard sound meter				17.97

By proceeding in a similar manner relative to the characteristic of the particular sound meter considered (it is sufficient to substitute in Column 3 for the ordinates of the nominal curve A the corresponding data obtained for the particular sound meter with steady sinusoidal currents at various frequencies in such a way that 0 decibel is obtained at 100 p : s) another value for the sum of the weighted powers will be obtained. If this value is the same as that obtained by the calculation using the nominal operating characteristic at various frequencies, the particular sound meter must be calibrated so as to give a reading of 0 decibel for the reference acoustic intensity at 1 000 p : s. If the sum of the weighted powers for the given sound meter differs from that for the standard sound

meter, the given sound meter must be calibrated so that the reference acoustic intensity at 1 000 p : s gives a reading of x decibels where :—

$$x = 10 \log_{10} \frac{\text{sum of the weighted powers for the standard sound meter.}}{\text{sum of the weighted powers for the given sound meter.}}.$$

To determine if the operating characteristic of the particular sound meter considered falls within the tolerances the characteristic of this given sound meter, displayed by x decibels, can be superposed on the nominal operating characteristic (standard sound meter). In this position, with regard to the nominal characteristic, the operating characteristic of the given sound meter should fall within the dotted lines shown in Fig. 1.* The direction of the displacement of x decibels is the following : if the sum of the weighted powers for the particular sound meter in question is smaller than the sum of the weighted powers for the standard sound meter the displacement of x decibels should be made upwards in Fig. 1.

A similar procedure must be followed to determine that the curve B given by the particular sound meter considered does not differ from the nominal curve " B " by a greater margin than the tolerances allowed, also to calibrate the sound meter with a view to its use with curve " B."

APPENDIX III.

BIBLIOGRAPHY FOR SOUND METERS.

I. GERMAN PUBLICATIONS.

H. **Sell,** Geräte für objektive Geraüschmessungen, *S. Z.*, Bd. 15 S. 147-153, 1935 (H. 5), *Z. f. Ht. u. E.*, Bd. 48, S. 34-38, 1936 (H. 1).

K. **Schoeps,** Suchtonverfahren für Geräuschanalyse, *Die Naturwissenschaften*, Bd. 24, S. 202, 1936 (H. 13).

E. **Lübcke,** Geräuschbildung und Geräuschminderung bei elektrischer Energieumsetzung, *Z. f. t. P.*, Bd. 16, S. 576-580, 1935 (H. 12).

K. W. **Wagner,** Physikalische Grundlagen und neuere Ergebnisse der Lärmbekämpfung, *Z. f. t. P.*, Bd. 16, S. 544-554, 1935 (H. 12).

H. J. v. **Braunmühl,** und W. **Weber,** Ein vielseitiges registrierendes Messund Steuergerät für elektroakustiche Zwecke, *E. N. T.*, Bd. 12, S. 223-231, 1935 (H. 8).

Schad, Die Geräusche elektrischer Maschinen, *Helios*, Bd. 41, S. 869-870, 1935 (H. 29).

Thilo und **Freystedt,** Messgeräte für Schalluntersuchungen, *S. Z.*, Bd. 15, S. 153-156, 1935 (H. 5).

Thilo und **Steudel,** Analyse von Geräuschen und ihr Zusammenhang mit der Lautstärke, *V. G. N.*, 1935, Bd. 5 (H. 1), S. 39-50.

E. **Lübcke,** Wege zur Geräuschverminderung an elektrischen Maschinen, *S. Z.*, Bd. 15, S. 157-164, 1935 (H. 5).

K. W. **Wagner,** Fortschritte in der Geräuschforschung und Lärmabwehr, *Zeitschrift des Vereins Deutscher Ingenieure*, Bd. 79, S. 531-540, 1935 (H. 18).

C. A. **Hartmann,** u. H. **Jacoby,** Technische Einrichtung zum Messen der Verzerrung elektroakustischer Geräte und zur spektralen Analyse, *E. N. T.*, Bd. 12, S. 163-172, 1935 (H. 6).

W. **Bürck,** P. **Kotowski** und H. **Lichte,** Die Lautstärke von Knacken, Geräuschen und Tönen, *Elektrische Nachrichtentechnik*, 1935, B. 12, S. 278-288 (H. 9).

H. **Halden,** Geräuschmessungen nach neuem, objektivem Verfahren, *Messtechnik*, 1934, Bd. X, S. 49-51 (H. 3).

W. **Willms,** Geräuschmessungen an elektrischen Maschinen, *E. T. Z.*, Bd. 56, S. 25-28 und 53-56, 1935 (H. 2 und 3).

—Zur Messung der Lautstärke, Schalltechnik, 1933 Jg. 6, *S. Z.* (H. 1-2).

E. **Lübcke,** Zum mechanisch-akustischen Verhalten von elektrischen Maschinen, *Z. f. t. P.*, Bd. 15, S. 652-660, 1934 (H. 22).

C. **Trage,** Grundlagen der subjektiven und objektiven Lautstärkemessung, *E. T. Z.*, Bd. 55, S. 931-934, 1934 (H. 38).

W. **Jaeckel,** Akustische Geräte für praktischen Gebrauch, *Zeitschrift des Vereins Deutscher Ingenieure*, Bd. 77, S. 98-99, 1933 (H. 4).

J. **Diebitsch** und H. **Zuhrt,** Klanganalyse durch Steuerung des Sättigungsstromes einer Zweielektrodenröhre, *E. N. T.*, Bd. 9, S. 293-301, 1932 (H. 8).

H. **Barkhausen,** Geräuschmessung, *E. T. Z.*, Bd. 53, S. 710, 1932 (H. 29).

H. **Behrens,** Die Bedeutung des Geräuschmessers für die Lüftungstechnik, *S. Z.*, Bd. 12, S. 225-226, 1932 (H. 7).

G. **Bakos** und S. **Kagan,** Geräusch-und Lärmmessungen, *Zeitschrift des Vereins Deutscher Ingenieure*, Bd. 76, S. 145-150, 1932 (H. 7).

M. **Grützmacher,** Zur Analyse von Geräuschen, *Z. f. t. P.*, Bd. 10, S. 570-572, 1929 (H. 11).

H. **Salinger,** Zur Theorie der Frequenz-Analyse mittels Suchton, *E. f. t.*, Bd. 6, S. 293-302, 1929 (H. 8).

* English Edition, 1934, page 501.

H. Barkhausen und **H. Tischner,** Die Lautstärke von Zusammengesetzten Tönen und Geräuschen, *Z. f. t. P.*, Bd. 8, S. 215, 1927 (H. 6).

H. Fassbender und **H. Krüger,** Geräuschmessungen in Flugzeugen, *Z. F. T. P.*, Bd. 8, S. 277, 1927 (H. 7).

H. Barkhausen, Ein neuer Schallmesser für die Praxis, *Z. f. t. P.*, Bd. 7, S. 599-601, 1926 (H. 12).

U. Steudel, Ueber Empfindung und Messung der Lautstärke, *Z. f. H. t. u. E.*, 1933, Bd. 41, S. 116 (H. 4).

II. AMERICAN PUBLICATIONS.

O. Knudsen, Harvey Fletcher and **R. G. McCurdy.** Articles on the Standardisation of Acoustical Measurements and Terminology: *Industrial Standardisation and Commercial Standards Monthly*, April, 1936.

III. BRITISH PUBLICATIONS.

British Standards Institution publication No. 661 of 1936: *Glossary of Acoustical Terms and Definitions.*

A. H. Davis, The Measurement of Noise: Physical Society Report of a Discussion on Audition, June, 1931.

B. G. Churcher, A. J. King and **H. Davies,** The Measurement of Noise with Special Reference to Engineering Noise Problems; *Journal Inst. Electrical Engineers*, vol. 75, p. 401, 1934.

N. R. Campbell and **G. C. Marris.** The Measurement of Loudness, *Proc. Phys. Society*, vol. 47, p. 153, 1935.

IV. FRENCH PUBLICATIONS.

P. Chavasse, Note sur les bruits et leur mesure, *Annales des P. T. T.*, janvier, 1932.

Baron, La mesure et l'analyse des bruits produits par les machines electriques, *Bulletin de la Société française des électriciens*, novembre, 1932.

Cellerier, Etude des bruits et de l'isolement phonique des materiaux et des batiments, *Revue générale d'électricité*, 29 octobre, 1932.

V. SWEDISH PUBLICATIONS.

At the Royal Polytechnic School, Stockholm, is a special section which has for some years conducted tests and researches on sound insulation obtainable with certain building materials. The results of these researches are given in the publication Ingenjörsvetenskapsakademiens handlingar, No. 132 (Actes de l'Academie Royale suedoise des sciences techniques, No. 132) and in the following periodicals:—

I. V. A., 1935, No. 1 (published by the above Academy);

Byggmästaren (The Building Constructor): 1931, No. 37; 1932, No. 18; 1933, No. 13; 1936, No. 12.

These publications, in the Swedish language, present several general points of view concerning subjective and objective measurements of acoustic intensity, and state the results of the researches undertaken. They also contain a description of the apparatus used for the researches, but there is no mention of the construction of the Swedish sound meters. However, in September 1936, a Swedish type of sound meter was made by the Aga Baltic Co. (Radio-aktiebolaget Aga-Baltic) to the specifications of the Royal Polytechnic School; nothing has yet been published concerning the construction of this apparatus.

PAGE 514.

In the section entitled "The Putting into Service of a New Circuit," the first item under the second paragraph should now read :—

Type of Circuit (two-wire, four-wire or carrier).

PAGE 515.

The foot-note should now read as follows :—

* By correct value is understood the nominal value with permissible tolerances of the relative power levels at frontier stations, i.e. from 300 to 400 p : s and from 2 400 to 2 600 p : s a tolerance of between − 0.5 neper or − 4.4 decibels and + 0.15 neper or + 1.3 decibel; from 400 to 600 p : s and from 2 000 to 2 400 a tolerance of between − 0.3 neper or − 2.6 decibels and + 0.15 neper or + 1.3 decibel; from 600 to 2 000 p : s a tolerance of ± 0.15 neper or ± 1.3 decibel (with a reservation that under no circumstances should the relative power level exceed + 1.1 neper or 9.6 decibels).

PAGE 516.

"Section C. Final measurements and Tests on Complete Circuits." In the second paragraph and after the words "is then measured," make reference to a foot-note as follows :—

The overall attenuation of the circuit is then measured*

and at the bottom of the page add the foot-note (*) as follows :—

*As far as possible transmission level recording sets should be used in periodical maintenance tests of international circuits used for commercial telephony.

PAGE 517.

At the end of paragraph " 2.a. *Tests made on Completed Circuits," insert a second paragraph as follows :—*

As far as possible transmission level recording sets should be used for periodical maintenance tests of international circuits used for commercial telephony.

PAGE 518.

At the top of the page continue the sub-section " (b) *Measurements to be made on Repeaters" by the following :—*

On telephone circuits used simultaneously for telegraphy any interruption, however short, of the telegraph transmission, should be avoided during the measurement of repeater gain. The precautions to be taken are given in the Appendix 2 entitled " Conditions to be satisfied by circuits used for voice frequency telegraphy."

These conditions also hold good for telephone circuits used simultaneously for super-audio telegraphy. It is even advisable only to change over to other equipment (repeater or complete system) during a period when telegraphic transmission is suspended.

To draw the attention of the personnel to this point it is advisable that circuits used for voice frequency or super-audio telegraph should bear a distinguishing mark, both in the intermediate repeater stations and the terminal exchanges.

PAGE 519.

Under " (c) *In all Repeater Stations : Measurements and Tests made on the Repeaters." Item* (γ) *should now read :—*

(γ) Valve rejection test.....Frequency to be agreed by Administrations and Operating Companies so that during a valve rejection it may be practically certain that the variation in gain will not exceed during the test the permissible limits (see above : " General characteristics of repeaters ").

PAGE 520.

Sub-section 4 (a) *" Measurement of overall attenuation and relative levels." The first paragraph should now read as follows :—*

Measure the overall attenuation and frontier levels on each of the circuits at a frequency of 800 p : s and at the frequencies indicated in the " Programme of Periodic Measurements (see Appendix IV below). The sub-control stations responsible for the circuits in the various national sections should be requested by the control station to take part in all the tests. Note the results.

PAGE 521.

Insert a fresh paragraph towards the end of the above sub-section " 4 (a) *" (commencing on p.* 520) *between the paragraph ending " . . . of the last repeater in question," and the penultimate paragraph commencing " In order to facilitate . . ." The new paragraph reads :—*

A national section is considered to be faulty when the difference in output level of the two frontier stations at the ends of this national section amounts to ± 0.15 neper with reference to the nominal difference shown in the level recorder.

PAGE 524.

At the bottom of the page add the following note :—

Note concerning the maintenance of circuits used for super-audio telegraphy.

The frequency with which periodical maintenance tests are made should be the same as that for the circuits when they are not used for super-audio telegraphy.

During level measurements in repeater stations it is necessary to withdraw the complete circuit (both telephonic and telegraphic) from service after agreement between the two services interested because the presence of either telephone or telegraph current would falsify the measurements. During these measurements of overall attenuation and levels the separating filters should be cut out of circuit (see above conditions concerning the setting up of circuits to be used for super-audio telegraphy).

PAGE 527.

Commence the foot-notes beneath Appendix III with the following note :—

Note.—The level diagrams of international circuits are established with the origin of the circuit in terminal service.

PAGE 529.

" Appendix IV." The frequencies at which the overall attenuation tests are made (see heading of column 8), *should read :—*

500, 800, 1 400, 2 000, 2 400 and 2 800 p : s.

PAGE 531.

In sub-section " C. Measurement of overall attenuation and levels," at the end of the second paragraph insert a new paragraph as follows :—

The use of automatic level recorders is strongly recommended in view of the great reduction in testing time obtained.

PAGE 534.

The " Note " in the middle of the page should now read as follows :—

To ensure that radio broadcasts shall be as satisfactory as possible the duration of the preparatory period must be strictly respected and a period of at least a quarter of an hour should be agreed upon for the adjustment period which immediately precedes the preparatory period.

The use of automatic level recorders would greatly facilitate the carrying out of this recommendation. In the case of a multiple broadcast the measurements required to be made by Administrations and Operating Companies to ensure that the circuits are satisfactory may be too numerous to be made in the short adjustment period preceding the preparatory period of the multiple broadcast. In this case these measurements can be made on the night before the multiple broadcast or on the same day but several hours beforehand, after agreement between the control and sub-control stations.

PAGE 536.

At the end of " Volume IV " and before " Volume V," insert the following :—

BIBLIOGRAPHY OF TELEPHONE TRANSMISSION

ABBREVIATIONS.

(a) Publications in German.

A. f. E.	Archiv für Elektrotechnik.
E. F. D.	Europäischer Fernsprechdienst.
E. N. T.	Elektrische Nachrichtentechnik.
E. T. Z.	Elektrotechnische Zeitschrift.
F. i. W.	Das Fernsprechen im Weitverkehr.
Fk.	Das Fernkabel.
F. M. T.	Zeitschrift für Fermeldetechnik, Werk- und Gerätebau.
M. TRA.	Mitteilungen aus dem Telegraphentechnischen Reichsamt.
Ph. Z.	Physikalische Zeitschrift.
S. Z.	Siemens-Zeitschrift.
T. M. schweiz. T. T. V.	Technische Mitteilungen herausgegeben von der Schweizerischen Telegraphen- und Telephon-Verwaltung.
T. u. F. T.	Telegraphen-, Fernsprech- und Funk- Technik.
V. G. N.	Veröffentlichungen aus dem Gebiete der Nachrichtentechnik.
W. V. S. K.	Wissenschaftliche Veröffentlichungen aus dem Siemenskonzern.
Z. f. t. P.	Zeitschrift für technische Physik.
Z. f. Ht. u. E.	Zeitschrift für Hochfrequenztechnik und Elektroakustik.

(b) Publications in English.

B. repr.	Bell Reprint.
B. S. T. J.	Bell System Technical Journal.
B. T. Q.	Bell Telephone Quarterly.
Elec.	The Electrician.
Electrochem. Soc.	Electrochemical Society.
El. Com.	Electrical Communication.
El. Eng.	Electrical Engineering.
El. Rev.	Electrical Review.
El. W.	Electrical World.
Eng.	Engineering.
G. E. R.	General Electric Review.
I. P. O. E. E.	Institution of Post Office Electrical Engineers.
J. A. I. E. E.	Journal of the American Institute of Electrical Engineers.
J. A. S. A.	Journal of the Acoustical Society of America.
J. Fr. I.	Journal of the Franklin Institute.
J. I. E. E.	Journal of the Institution of Electrical Engineers.
J. S. M. P. E.	Journal of the Society of Motion Picture Engineers.
Mech. Eng.	Mechanical Engineering.
P. O. E. E. J.	Post Office Electrical Engineers' Journal.
Phys. Rev.	Physical Review.
Pr. I. R. E.	Proceedings of the Institute of Radio Engineers.
Pr. Ph. S.	Proceedings of the Physical Society of London.
T. A. I. E. E.	Transactions of the American Institute of Electrical Engineers.
W. P.	World Power.
W. W. & R. R.	Wireless World and Radio Review.

(c) Publications in French.

A. P. T. T.	Annales des Postes, Télégraphes et Téléphones.
B. P. T. T.	Bulletin de l'Administration française des P.T.T.
B. S. F. E.	Bulletin de la Société française des Electriciens.

B. S. I. E.	Bulletin de la Société des Ingénieurs Electriciens.
B. Techn. T. T. suisses	Bulletin technique de l'Administration des Télégraphes et Téléphones suisses.
Ecl. Elec.	Eclairage Electrique.
Gén. Civ.	Génie Civil.
Ind. Elec.	Industrie Electrique.
Ind. V. F. et T. A.	Industrie des Voies ferrées et des Transports automobiles.
Journ. Phys. et Rad.	Journal de Physique et le Radium.
Journ. Télégr.	Journal Télégraphique (publié par le Bureau International de l'Union Télégraphique).
Lum. Elec.	Lumière électrique.
Onde Elec.	Onde électrique.
Rad. Elec.	Radioélectricité.
R. G. E.	Revue Générale de l'Electricité.
R. T. T. et TSF.	Revue des Téléphones, Télégraphes et T. S. F.
Tech. Mod.	Technique moderne.
T.S.F. Mod.	T. S. F. moderne.

I. PUBLICATIONS IN GERMAN.

(a) 1. General: Transmission Standards and Definitions.

Die Wahl eines internationalen Masses für die Güte von Fernleitungsverbindungen, F. BREISIG, *Fk.*, 1923, No. 3, p 11.

Verfahren über Vierpolmasse, H. SCHULZ, *T. u. F. T.*, 1923, p. 269.

Ueber das Fernsprech-Uebertragungsmass, F. BREISIG, *E. T. Z.*, 1924, p. 73, und *F. i. W.*, 1923, p. 35.

Welche Bedeutung hat für die Fernsprechverwaltungen die Wahl eines neuen Uebertragungsmasses? F. BREISIG, *E. F. D.*, 1926, No. 2, p. 21.

Der Stand der Frage des Fernsprech-Uebertragungsmasses, F. BREISIG, *E. N. T.*, 1926. p. 55.

Uebertragungsmass und Vierpolparameter, F. BREISIG, *E. N. T.*, 1926, p. 161.

Welches Uebertragungsmass ist zum Gebrauch in der Ferntelephonie zweckmässig, und wie wird es gemessen? H. SCHULZ, *T. u. F. T.*, 1926, pp. 161, 265 und 370.

Ueber logarithmische Masse von Verhältnissen gleichartiger Grössen und über die Frage ihrer Stellung zum absoluten Masssystem, F. BREISIG, *E. F. D.*, Sonderheft (Como) 1927, p. 5.

Das Dämpfungsmass der Pupinleitung, H. F. MAYER, *T. u. F. T.*, 1927, p. 163.

Die Betriebsdämpfung, H. SCHULZ, *E. N. T.*, 1928, p. 449.

Ausgewählte Kapitel aus der Elektroakustik, F. LÜSCHEN, *T. u. F. T.*, 1928, p. 125 und p. 163.

Zur Theorie der Frequenzanalyse mittels Suchtons. H. SALINGER, *E. N. T.*, 1929, p. 293.

Der Fernsprech-Haupteichkreis, WOLMANN und DÖRING, *T. u. F. T.*, 1930, p. 59.

Ein neues elektrodynamisches Bandmikrophon, C. A. HARTMANN, *E. N. T.*, 1931, p. 289.

Ueber den Begriff der Echodämpfung, P. OEHLEN, *E. F. D.*, No. 32, 1933, p. 81.

Kurventafeln zur Ermittlung der Betriebsdämpfung zusammengesetzter Vierpole, P. BEHREND, *T. u. F. T.*, 1934, p. 159.

Die Fernsprechbetriebsmasse. Ihre Entstehung, Bedeutung, kritische Würdigung und Verallgemeinerung, H. SCHULZ, *E. F. D.*, No. 37, 1934, p. 229.

Durchgriffsverzerrung, R. FELDTKELLER, *E. N. T.*, 1934, p. 403.

Grundlagen der subjektiven und objektiven Lautstärkemessung, C. TRAGE, *E. T. Z.*, 1934, p. 931.

Die Bemerkbarkeit von Einschwingzeiten, F. STRECKER, *T. u. F. T.*, 1935, p. 1.

(a) 2. General: Recommendations of Principle.

Ueber Dämpfung und Verzerrung von homogenen Fernsprechleitungen. Allgemein und beschränkt gültige Verzerrungsmasse, H. SCHULZ, *T. u. F. T.*, 1924, p. 123.

Ueber den Eingangswiderstand von Vierpolen geringer Dämpfung, R. FELDTKELLER, *T. u. F. T.*, 1925, p. 189.

Der Einfluss des Leitungsabschlusses auf das Nebensprechen, D. WEHAGE, *M. TRA.*, vol. X, 1925, p. 109.

Neue Rechenbehelfe für Berechnungen von Fernsprechübertragungen, F. BREISIG, *E. T. Z.*, 1925, p. 1726.

Ueber die kleinste Rückkopplungsverzerrung bei einer Zweidrahtverbindung mit Zweidraht-Zwischenverstärkern, R. FELDTKELLER, *T. u. F. T.*, 1926, p. 97.

Ueber Einschwingvorgänge in Pupinleitungen und ihre Verminderung, K. KÜPFMÜLLER und H. F. MAYER, *W. V. S. K.*, vol. V, No. 1, 1926, p. 51

Die Erhöhung der Reichweite von Pupinleitungen durch Echosperrung und Phasenausgleich, K. KÜPFMÜLLER, *E. N. T.*, 1926, p. 82.

Die Messung des Uebertragungsmasses von Vierpolen nach der Kompensationsmethode, H. F. MAYER, *E. N. T.*, 1926, p. 141.

Ueber die Verbindung von Vierdrahtleitungen untereinander, K. HÖPFNER, *T. u. F. T.*, 1927, p. 166.

Ueber die Betriebsdämpfung symmetrischer Vierpole, R. FELDTKELLER, *W. V. S. K.*, vol. VI, No. 2, 1927, p. 106.

Ueber die zweckmässigste Pupinisierungsart von Fernkabeln, F. LÜSCHEN und K. KÜPFMÜLLER, *E. F. D.*, No. 4, 1927, p. 10.

Zur Konstruktion des Eingangswiderstandes symmetrischer Vierpole, R. FELDTKELLER, *W. V. S. K.*, vol. VII, No. 1, 1928, p. 254.

Diagramme zur Berechnung von Vierpolen konstanten Wellenwiderstandes, V. GANDTNER und G. WOHLGEMUTH, *W. V. S. K.*, vol. VII, No. 2, 1928, p. 67.

Ueber das Nebensprechen und andere damit zusammenhängende Erscheinungen, T. LAURENT, *E. N. T.*, 1928, p. 179.

Die Betriebssicherheit in Fernkabelanlagen, A. MENTZ, *E. F. D.*, Nos. 12-13, 1929, p. 128.

Der Einfluss der Schwankungen des Kabelwellenwiderstandes auf die Restdämpfung einer Fernsprechleitung ohne Rückkopplungsverzerrung, H. DECKER, *T. u. F. T.*, 1929, p. 102.

Ergebnisse der Versuche mit einem neuen Pupinisierungssystem mit erhöhter Grenzfrequenz und mit Phasenausgleich im Fernkabel Hannover-Wiedenbrück, K. HÖPFNER, *T. u. F. T.*, 1929, p. 148; und *E. F. D.*, Nos. 12-13, p. 118.

Widerstandstheorie und Leitwerttheorie des Vierpols, J. WALLOT, *W. V. S. K.*, vol. VIII, No. 2, 1929, p. 45.

Scheinwiderstände und Uebertragungsgrössen allgemeiner Vierpole, F. STRECKER und R. FELDTKELLER, *W. V. S. K.*, vol. VIII, No. 2, 1929, p. 70.

Grundlagen der Theorie des allgemeinen Vierpols, F. STRECKER und R. FELDTKELLER, *E. N. T.*, 1929, p. 93.

Das neue Pupinisierungssystem für Fernsprechleitungen mit erhöhter Grenzfrequenz und Phasenausgleich, F. Lüschen und H. F. Mayer, *E. N. T.*, 1929, p. 139.

Durchlassbereich, Phasenlaufzeit und Klirrfaktor von Fernkabeln, M. Grützmacher, *E. N. T.*, 1929, p. 386.

Ueber die günstigste Verstärkerfelddämpfung von Zweidrahtleitungen, W. Weinitschke, *E. N. T.*, 1930, p. 141.

Bemerkungen zum einheitlichen Fernkabelsystem, R. Wicar und K. György, *E. F. D.*, No. 15, 1930, p. 9.

Antwort auf die "Bemerkungen zum einheitlichen Fernkabelsystem" der Herren R. Wicar und K. György, F. Lüschen, *E. F. D.*, No. 15, 1930, p. 19.

Zur Gestaltung des deutschen Fernleitungsnetzes, Hartz, *E. F. D.*, No. 19, 1930, p. 311.

Das Nebensprechen in Fernsprechkabeln, Willi Doebke, *E. N. T.*, 1931, p. 63.

Die Hysteresedämpfung von Pupinleitungen, Willi Doebke, *E. N. T.*, 1931, p. 340.

Reichweite und Wirtschaftlichkeit der Fernkabelleitungen nach dem System II des CCI, K. Höpfner und F. Lüschen, *E. F. D.*, No. 21, 1931, p. 3.

Planzeug für das deutsche Fernkabelnetz, Th. Mantzel, *E. F. D.*, No. 23, 1931, p. 186.

Eine Verzögerungsleitung für Messung und Vorführung von Laufzeitwirkungen in Fernmeldesystemen, H. Decker *E. N. T.*, 1931, p. 516.

Oeffentliche und andere Nachrichtennetze, Kölsch, *E. F. D.*, No. 24, 1931, p. 243.

Der Aufbau des deutschen Fernleitungsnetzes und die Leitung der Durchgangsgespräche, Hartz, *E. F. D.*, No. 28, 1932, p. 92.

Verzerrungen bei Mikrophonen und Lautsprechern, C. A. Hartmann, *Z. f. t. P.*, 1932, vol. 13, p. 9.

Die für lange Fernsprechleitungen zulässige Uebertragungszeit, H. Decker, *E. F. D.*, No. 28, 1932, p. 133.

Moderne Nachrichtensysteme, F. Lüschen, *E. F. D.*, No. 29, 1932, p. 171.

Stossfaktor und Stossdämpfung, R. Führer, *T. u. F. T.*, 1932, p. 263.

Zur Theorie und Berechnung der Betriebsdämpfung in einfachen und zusammengesetzten Uebertragungssystemen, G. Hoecke, *T. u. F. T.*, 1932, p. 1 und p. 77.

Ueber die Frequenzabhängigkeit der Dämpfung in nicht angepassten einfachen Uebertragungssystemen, G. Hoecke, *T. u. F. T.*, 1933, p. 152 und p. 174.

Neubildung von unterdrückten Sprachfrequenzen durch ein nichtlinear verzerrendes Glied, K. Schmidt, *T. u. F. T.*, 1933, p. 13.

Nichtlineare Kennlinienfelder, R. Feldtkeller und W. Jacobi, *T. u. F. T.*, 1933, p. 198.

Nichtlineare Verzerrungen von Mikrophonen, H. J. v. Braunmühl und W. Weber, *E. T. Z.*, 1933, pp. 1068-70.

Betriebswirtschaftliche Betrachtungen über das deutsche Fernleitungsnetz, Kölsch, *E. F. D.*, No. 31, 1933, p. 14

Ueber Empfindung und Messung der Lautstärke, U. Steudel, *Z. f. Hf. u. E.*, 1933, vol. 41, p. 116.

Kapazitäts-Unsymmetrie-Ausgleich bei viererverseilten Kabeln, E. Gay, *T. M. schweiz. T. T. V.*, April, 1933.

Das neue Fernkabelsystem in Holland, de Voogt, *E. F. D.*, No. 34, 1934, p. 32.

Ueber die Dämpfungen der Fernsprechleitungen und Fernsprechverbindungen, F. Wiedemann, *T. u. F. T.*, 1934, p. 53, p. 93 und p. 137.

Eingangswiderstand und Betriebsdämpfung von Vierpolen, W. Weinitschke, *T. u. F. T.*, 1934, p. 87.

Neuere Untersuchungen über nichtlineare Verzerrungen elektro-akustischer Uebertragungs- und Aufzeichnungsgeräte, H. J. v. Braunmühl, *Z. f. t. P.*, 1934, vol. 15, No. 12, pp. 617-22.

Ueber Störungen im Fernkabelnetz, Hartz, *E. F. D.*, No. 34, 1934, p. 34.

Ueber Fernamtstrennung, Hartz, *E. F. D.*, No. 35, 1934, p. 94.

Fernleitungen mit zweidrähtiger Seekabelstrecke hoher Dämpfung, P. Oehlen, *T. u. F. T.*, 1934, p. 293 und *E. F. D.*, No. 38, 1935, p. 43.

Die Messung des Sprachvolumens auf Leitungen, R. Tamm und C. Hartmann, *V. G. N.*, 1934, p. 309.

Die Berechnung der Fortpflanzungskonstante der Pupinleitung, A. K. Kotelnikoff, *E. F. D.*, No. 41, 1935, p. 229.

Unsymmetrie von Schaltgliedern, R. Führer, *T. u. F. T.*, 1935, p. 271.

Der Einfluss des beschleunigten Fernverkehrs auf die Gestaltung des Fernleitungsnetzes, K. Schotte, *T. u. F. T.*, 1935, p. 299.

Technische Einrichtung zum Messen der Verzerrungen elektroakustischer Geräte und zur spektralen Analyse, C. A. Hartmann und H. Jacobi, *E. N. T.*, 1935, vol. 12, No. 6, pp. 163-172.

Ueber die Betriebs- und Kopplungskapazitäten zwischen den Leitungssystemen eines Vierers, H. Kaden, *V. G. N.*, 1935, p. 149.

Zur Theorie der Schaltungen mit konstantem Wellenwiderstand "Brücken-T-Schaltungen," R. Feldtkeller, *V. G. N.*, 1935, p. 155.

Nachrichtenfluss und Frequenzbandbreite, F. Strecker, *V. G. N.*, 1935, p. 227.

Ueber die Addition von Geräuschspannungen, P. Oehlen, *T. u. F. T.*, 1936, p. 17.

Die nichtlineare Verzerrung in langen Fernsprechkabeln und ihr Einfluss auf die Verständlichkeit der Sprache, F. Lüschen, *T. u. F. T.*, 1936, p. 27.

Ueber die Theorie des gleichachsigen Breitbandkabels idealer Ausführung, H. W. Droste, *T. u. F. T.*, 1936, p. 145.

Leitbehelfe für den zwischenstaatlichen Fernsprechverkehr, Ehlers, *E. F. D.*, No. 42, 1936, p. 21.

Wie werden die Ferngespräche im deutschen Netz geleitet? Hartz, *E. F. D.*, No. 43, 1936, p. 90.

(b) 1. General Rules concerning Transmission Systems for Ordinary Telephony.

Das Fernsprechen auf weite Entfernungen, K. W. WAGNER, *F. i. W.*, 1923, p. 6, und *E. T. Z.*, 1924, pp. 1 und 25.

Die Berechnung der Rückkopplungsverzerrung bei Leitungen mit Zweidrahtzwischenverstärkern, R. FELDTKELLER, *T. u. F. T.*, 1925, p. 274.

Phasenausgleich, K. KÜPFMÜLLER, *E. N. T.*, 1926, p. 82.

Echosperrer für Fernverbindungen, H. F. MAYER und H. NOTTEBROCK, *T. u. F. T.*, 1926, p. 363 und *S. Z.*, 1926, p. 446.

Die Dämpfung von Leitungen, deren Widerstand und Selbstinduktion stromabhängig ist, U. MEYER, *E. N. T.*, 1926, p. 33.

Die Uebertragungseigenschaften von Fernkabelverbindungen, K. KÜPFMÜLLER, *E. F. D.*, No. 5, 1927, p. 19.

Ueber Beziehungen zwischen Frequenzcharakteristiken und Ausgleichsvorgängen in linearen Systemen, K. KÜPFMÜLLER, *E. N. T.*, 1928, p. 18, und *E. F. D.*, Sonderheft "Como," 1927, p. 25.

Ueber die Theorie der Anlaufvorgänge, F. BREISIG, *E. N. T.*, 1928, p. 214.

Dämpfungsentzerrung und Phasenverzerrung, H. DECKER, *E. N. T.*, 1928, p. 163.

Ein neuer Rückkopplungssperrer, W. HAHN und H. WARNCKE, *E. N. T.*, 1928, p. 522.

Ergebnisse neuerer Untersuchungen an Zweidrahtverstärkerleitungen, W. WEINITSCHKE, *T. u. F. T.*, 1928, p. 135.

Von der Einführung des Tonfrequenzrufverfahrens für Zweidrahtverstärkerleitungen bei der Deutschen Reichspost, W. WEINITSCHKE, *T. u. F. T.*, 1929, p. 61.

Ein Beitrag zur Theorie der Rückkopplungen in Zweidrahtleitungen, W. WEINITSCHKE, *E. N. T.*, 1929, p. 399.

Ueber die Hörbarkeit von Verzerrungen, W. JANOVSKY, *E. N. T.*, 1929, p. 421.

Ueber die Benutzung verzerrungsfreier Verlängerungsleitungen im Zweidrahtverstärkerbetrieb, P. OEHLEN, *T. u. F. T.*, 1929, p. 140.

Ueber das Nebensprechen "bei Sprache" in Pupinkabeln, Fritz HAAS, *E. N. T.*, 1930, p. 307.

Theorie der Niederfrequenz-Verstärkerketten, R. FELDTKELLER und F. STRECKER, *A. f. E.*, vol. XXIV, No. 4, 1930, p. 425.

Fernsprechtechnik im Fernsprechnetz, R. WINZHEIMER, *T. u. F. T.*, 1931, p. 149.

Fastlineare Netzwerke, R. FELDTKELLER und W. WOLMANN, *T. u. F. T.*, 1931, p. 167 und p. 242.

Ein Beitrag zur Frage der Verwendung von Endverstärkern im Fernleitungsnetz, R. WINZHEIMER, *E. F. D.*, No. 27, 1932, p. 17.

Schalttechnik und Uebertragungstechnik, R. WINZHEIMER, *E. F. D.*, No. 33, 1933, p. 153.

Detonierende Verstärker, H. DECKER, *E. N. T.*, 1933, p. 416.

Die Rückkopplungssperre für die drahtlosen Gegensprechverbindungen der Deutschen Reichspost, R. RÜCKLIN, *E. N. T.*, 1934, p. 75.

Die Gefahr der wechselseitigen Verriegelung von Echosperren, H. DECKER, *E. N. T.*, 1934, p. 238.

Die Ueberwindung der Gefahr wechselseitiger Verriegelung von Echosperren, H. DECKER, *E. N. T.*, 1934, p. 281.

Echosperren im Weltfernsprechnetz, F. STRECKER, *V. G. N.*, 1934, p. 313.

Die Wirkungsweise von Echosperren, F. STRECKER, *E. F. D.*, No. 38, 1935, p. 29.

Ueber Fragen des Selbstwählfernverkehrs, R. HARTZ, *E. F. D.*, No. 39, 1935, p. 98.

Die Gruppenlaufzeit elektrischer Uebertragungssysteme, R. FELDTKELLER, *V. G. N.*, 1935, p. 21.

Vorschlag einer Rückkopplungssperrung mit sprachgesteuertem Relais für drahtlosen Gegensprechverkehr, R. KOLL, *E. N. T.*, 1936, p. 20.

(b) 2. General Rules concerning Transmission Systems for Carrier Telephony.

Elektrische Kettenleiter und ihre technischen Anordnungen, K. W. WAGNER, *M. TRA.*, vol. IX, 1923, p. 289 und *Z. f. t. P.*, vol. II, 1921, p. 297.

Der allgemeine Kettenleiter, K. W. WAGNER, *M. TRA.*, vol. X, 1925, p. 141 und *Telefunken Zeitung*, vol. VI, Nos. 34-35, 1924, p. 21.

Einschaltvorgänge bei Siebketten mit beliebiger Gliederzahl, K. W. WAGNER, *M. TRA.*, vol. X, 1925, p. 1 und *W. V. S. K.*, vol. II, 1922, p. 189.

Die Theorie des Kettenleiters nebst Anwendungen, K. W. WAGNER, *A. f. E.*, 1915, p. 315, und *M. TRA.*, vol. VIII, 1925, p. 211.

Spulen und Kondensatorleitungen, K. W. WAGNER, *A. f. E.*, vol. VIII, 1919, p. 61, und *M. TRA.*, vol. VIII, 1925, p. 283.

Modulation und Frequenztrennung als Mittel der Mehrfachausnutzung einer Leitung, H. SCHULZ, *E. N. T.*, 1926, p. 95.

Ueber Anpassung und Nachbildung von Kettenleitern, F. STRECKER und R. FELDTKELLER, *W. V. S. K.*, vol. 5, No. 3 1927, p. 128.

Kettenleiter und Wellensiebe, K. W. WAGNER, *E. N. T.*, 1928, p. 1, und *E. F. D.*, Sonderheft "Como," 1927, p. 8.

Ueber einige Endnetzwerke von Kettenleitern, R. FELDTKELLER, *E. N. T.*, 1927, p. 253.

Ueber das Verhalten symmetrischer, verlustfreier Kettenleiter zwischen ohmschen Widerständen, R. FELDTKELLER, *E. N. T.*, 1928, p. 145.

Ueber den Einfluss des Phasenmasses und der Dämpfung bei der Uebertragung von modulierten Wellen, H. BARTELS *W. V. S. K.*, vol. VII, No. 1, 1928, p. 260.

Zweibandtelephonie, H. F. MAYER, *T. u. F. T.*, 1929, p. 312.

Versuche mit dem Zweibandsprechen im 3. deutsch-schwedischen Fernsprechkabel, K. HÖPFNER, *E. F. D.*, No. 14, 1929, p. 229.

Die Wirtschaftlichkeit der Zweibandtelephonie auf Pupinseekabeln, H. F. MAYER und G. MÜCKE, *E. F. D.*, No. 20, 1930, p. 370.

Zweibandsprechen von Helgoland nach Cuxhaven und Hamburg, W. WEINITSCHKE, *T. u. F. T.*, 1930, p. 310.

Der Ausbau der Fernsprechwege von Deutschland nach Lettland, Estland und nach der USSR für den Hochfrequenzträgerbetrieb, K. HÖPFNER, *E. F. D.*, No. 29, 1932, p. 166.

Die neuere Entwicklung der Trägerfrequenztelephonie auf Leitungen, K. KÜPFMÜLLER, *E. F. D.*, No. 30, 1932, p. 229, und No. 31, 1933, p. 27.

Ueber die Möglichkeiten und Vorteile des Zweibandfernsprechens auf Landfernkabeln, K. SCHMIDT, *T. u. F. T.*, 1932, p. 68.

Die Mehrfachausnutzung von Fernsprechleitungen mit Hilfe der Hochfrequenztelephonie, F. VOGEL und H. ROLOFF, *V. G. N.*, 1932, p. 199.

Mehrfach-Trägerfrequenztelephonie auf mehreren Doppelleitungen desselben Gestänges, R. FELDTKELLER, *V. G. N.*, 1933, p. 117.

Hochfrequenz-Einfachtelephonie-System der Siemens & Halske A. G., F. VOGEL H. und ROLOFF, *V. G. N.*, 1933, p. 233.

Hochfrequenztelephonie auf Leitungen mit kürzeren Trägerwellen, F. KIRSCHSTEIN und J. LAUB, *E. N. T.*, 1933, p. 457.

Trägerfrequenzsysteme für Fernkabelleitungen, K. DOHMEN und H. F. MAYER, *E. F. D.*, No. 34, 1934, p. 11.

Trägerstromtelephonie auf Kabelleitungen, H. F. MAYER, *T. u. F. T.*, 1936, p. 1.

(b) 3. General Rules concerning Transmission Systems for Radio Broadcasting.

Rundfunkleitungsverstärker der Siemens & Halske, A. G.; VOGEL, *S. Z.*, vol. XI, 1931, p. 333.

Kabelleitungen für die Uebertragung von Rundfunkdarbietungen, K. HÖPFNER, *E. F. D.*, No. 22, 1931, p. 107.

Die Leitung im Dienste des Rundfunks, K. HÖPFNER, *E. T. Z.*, vol. LII, 1931, pp. 1061 und 1087.

Die Uebertragung von Rundfunkprogrammen auf Kabelleitungen, H. F. MAYER, *T. u. F. T.*, 1931, p. 199.

Messung und Betriebsüberwachung von Rundfunkfernleitungsnetzen, L. FENYÖ und H. HOFFMANN, *T. u. F. T.*, 1931, p. 205.

Aussteuerungsgeräte im Rundfunkbetrieb, G. LUBSZYNSKI und H. WEIGT, *E. N. T.*, 1932, p. 4.

Die Entzerrung der Rundfunkfernleitungen, L. FENYÖ, *T. u. F. T.*, 1933, p. 275.

Rundfunkübertragungen, ANDEREGG, *E. F. D.*, No. 35, 1934, p. 75.

Das neue Rundfunkfernleitungs-System (Verst 34), L. FENYÖ und K. BAER, *T. u. F. T.*, 1934, p. 29.

Aufbau des neuen Rundfunkleitungs-Verstärkersystems (VRL 34), F. MAERKER, *V. G. N.*, 1934, p. 43.

Rundfunkübertragung auf Leitungen, F. VOGEL und U. HENNECKE, *V. G. N.*, 1934, p. 63.

Das deutsche Rundfunkleitungsnetz, P. SPRINCK, *E. T. Z.*, 1934, p. 61.

Rundfunkübertragung in Norwegen, W. RABANUS und S. RYNNING-TÖNNESSEN, *E. F. D.*, No. 41, 1935, p. 219.

Drahtfunk, F. GLADENBECK, *E. T. Z.*, 1935, p. 121; *T. u. F. T.*, 1935, p. 55.

Organisation und Technik bei der Weltringsendung am 27.10.1935, J. WEIL, *T. u. F. T.*, 1935, p. 289.

Trägerfrequente Rundfunkübertragung über Freileitungen, H. WERRMANN, *E. T. Z.*, 1936, pp. 707 und 735.

(b) 4. General Rules concerning Transmission Systems for Picture Transmission.

Drahtlose Bildtelegraphie, F. SCHRÖTER, *E. N. T.*, 1926, p. 41.

Bildtelegraphie, G. KETTE und W. KIEL, *T. u. F. T.*, 1927, p. 31.

Die Bildtelegraphie und das Problem des elektrischen Fernsehens, A. KORN, *E. F. D.*, Sonderheft "Como," 1927, p. 51.

Die neuesten Fortschritte des Bildtelegraphiesystems Telefunken-Karolus-Siemens, F. SCHRÖTER, *E. F. D.*, Sonderheft "Como," 1927, p. 62.

Der Bildfunk nach dem System Lorenz-Korn, W. SCHEPPMANN und A. EULENHÖFER, *E. N. T.*, 1928, p. 373.

Fortschritte in der Bildtelegraphie, F. SCHRÖTER, *E. N. T.*, 1928, p. 449.

Ueber die Anpassung einer Synchronmaschine an eine Elektronenröhre, H. BARTELS, *W. V. S. K.*, vol. VIII, No. 2, 1929, p. 1.

Ueber den Einfluss des Rasters bei der Bildtelegraphie, P. ARENDT, *E. N. T.*, 1930, p. 72.

Bildfunkkabel, R. FEIST und H. WEINNOLDT, *T. u. F. T.*, 1930, p. 299.

Die Abbildung beim Fernsehen, Erich HUDEC, *E. N. T.*, 1931, p. 229.

Stand der Fernbildübertragung, H. STAHL, *E. F. D.*, No. 21, 1931, p. 340.

Die Technik der Fernsehübertragung unter besonderer Berücksichtigung der Kabelfrage, F. BANNEITZ, *E. F. D.*, No. 40, 1935, p. 149.

Stand der Bildtelegraphie, H. STAHL, *E. T. Z.*, 1935, p. 341.

Einweihung der öffentlichen Fernseh-Sprechverbindung zwischen Berlin und Leipzig am 1. März 1936, F. GLADENBECK, *E. F. D.*, No. 43, 1936, p. 66.

(c) 1. Apparatus: Subscribers' Sets.

Masseinheiten für Mikrophone und Fernhörer, K. HERSEN, *F. i. W.*, 1923, p. 103, und *E. T. Z.*, 1924, p. 398.

Ueber Kohlemikrophone, M. GRÜTZMACHER und P. JUST, *E. N. T.*, 1931, p. 104.

Eine analytische Theorie des Telephons und ihre Bedeutung für das Experiment, H. HECHT, *E. N. T.*, 1931, p. 392.

Endverstärker für Teilnehmer, H. ROLOFF, *V. G. N.*, 1932, p. 147.

Widerstandsänderungen im Innern der Kohlekammer eines Kohlemikrophons, G. MADIA, *E. N. T.*, 1934, p. 337.

Theorie der akustischen Schwingungsausbreitung in gekörnten Substanzen und experimentelle Untersuchungen an Kohlepulver, G. HARA, *E. N. T.*, 1935, p. 191.

Die Bemessung der Rückhördämpfung von Fernsprechapparaten, K. BRAUN, *T. u. F. T.*, 1935, p. 109.

Das Rauschen von Kohlemikrophonen, R. OTTO, *Z. f. Ht. u. E.*, 1935, vol. 45, No. 6, p. 187-198.

Entwicklung und heutige Form des Nummernschalters in der Selbstanschlusstechnik, EBERST, *F. M. T.*, 1935, p. 57.

Die elektrischen Aufgaben der Nummernscheibe und die mechanischen Voraussetzungen und konstruktiven Massnahmen zu ihrer Lösung, EBERST, *F. M. T.*, 1935, p. 136.

Nummernschalter und Wählverhältnisse, KAUFMANN, *T. M. schweiz. T. T. V.*, 1935, p. 214.

Ueber die Neuentwicklung mittlerer W-Nebenstellenanlagen, G. WIRTH, *F. M. T.*, 1935, p. 161.

Gemeinschafts-Fernsprechanschlüsse in Deutschland, WITTIBER, *E. F. D.*, 1936, p. 31.

Ueber moderne Mikrophone und Telephone, H. JACOBY und H. PANZERBIETER, *E. N. T.*, 1936, p. 75.

Untersuchungen an Kohlemikrophonen, E. WAETZMANN und G. KRETSCHMER, *E. N. T.*, 1936, p. 149.

Elektroakustische Grundlagen der Güte des Fernsprechapparates, T. KORN, *E. N. T.*, 1936, p. 219.

Elektrische und akustische Eigenschaften der neuen Fernsprech-Tischstation Modell 36, A. PFEIFFER und F. PFLEIDERER, *V. G. N.*, 1936, p. 79.

(c) 2. Apparatus: Local Telephone Exchanges.

Die Stromstosssicherheit im Selbstanschlussbetrieb, R. FÜHRER, *T. u. F. T.*, 1935, p. 10.

Moderne Entwicklung der Wähler mit Einzelantrieb und grosser Geschwindigkeit in der Selbstanschluss-technik, LANGER, *F. M. T.*, 1935, p. 17.

Aufstellung von allgemeinen Grundsätzen zur Beurteilung von Wählern, MEHDORN, *F. M.* T., 1935, p. 87.

Ableitung der Bedingungen für die Nummernwahl in der Selbstanschluss-technik aus den Verhältnissen des Wahlvorganges, EBERST, *F. M. T.*, 1935, p. 97.

Neue Kassierstation für manuellen und automatischen Orts- und Fernverkehr, O. MOSER, *T. M. schweiz. T. T. V.*, Aug. 1933.

Die Telephoneneinrichtungen der Jungfraubahn, *T. M. schweiz. T. T. V.*, Oct. 1933.

Die vollautomatische Netzgruppe Zürich, P. SCHILD, *T. M. schweiz, T. T. V.*, Dec. 1934.

Verminderung der Sprechdämpfungen in Netzgruppen mit automatischen Zentralen System Hasler A.-G., J. KAUFMANN, *T. M. schweiz. T. T. V.*, Feb. 1935.

(c) 3. Apparatus: Toll Exchanges.

Berechnung der Sprechfrequenzverluste in Schnurstromkreisen mit in Brücke liegenden Scheinwiderständen, M. MERKER, *E. N. T.*, 1926, p. 172.

Schnurverstärker, E. NEUMANN, *M. TRA.*, vol. XI, 1926, p. 145, und *T. u. F. T.*, 1924, p. 197.

Ueber das Verhalten von Uebertragern zwischen ohmschen Widerständen, R. FELDTKELLER und H. BARTELS, *E. N. T.*, 1928, p. 247.

Scheinwiderstand und Betriebsdämpfung von Ringübertragern, R. FELDTKELLER und GANDTNER, *T. u. F. T.*, 1928, p. 375.

Der modulierte Tonfrequenzanruf in Fernkabelleitungen mit Verstärkern, G. GRIMSEN, *T. u. F. T.*, 1929, p. 104.

Die neuere Entwicklung der Schnurverstärkertechnik, E. NEUMANN, *T. u. F. T.*, 1929, p. 129.

Das neue Fernamt Berlin, K. SCHOTTE, *T. u. F. T.*, 1929, pp. 174, 251, 288, 320, 394; 1930, p. 17.

Eine Schaltungsanordnung zur Abhaltung von Sammelferngesprächen, H. DECKER, *E. N. T.*, 1930, p. 49.

Sammelverbindungen. Die Ferntagung des V. D. I. am 7. März 1930, R. WINZHEIMER, *E. F. D.*, No. 18, 1930, p. 224.

Das Durchgangsamt beim neuen Fernamt Berlin, K. SCHOTTE, *T. u. F. T.*, 1930, p. 348.

Bestimmung von Konstanten von Uebertragern geringer Dämpfung, P. OEHLEN, *T. u. F. T.*, 1931, p. 110.

Die Abnahmebedingungen der Deutschen Reichpost für Fernleitungsübertrager, P. OEHLEN, *T. u. F. T.*, 1931, p. 277.

Das Tonfrequenzfernwahlsystem der Siemens & Halske, A. G., W. H. THUROW, *F. M. T.*, 1931, p. 147.

Fernwahl und Tonfrequenzströme, *T. M. schweiz. T. T. V.*, 1932, p. 245.

Die Fernwahl, LUBBERGER, *T. M. schweiz. T. T. V.*, 1933, p. 41.

Städtewahl und Schnelldienst in Basel, E. FREY, *T. M. schweiz. T. T. V.*, Dec. 1933.

Das Tonfrequenzfernwahlsystem mit 2 Frequenzen der Siemens & Halske A. G., F. PFLEIDERER, *F. M. T.*, 1934, p. 113.

Betriebsmässige Bewertung der Fernleitungen bei Durchgangsfernämtern durch Gütezahlen, P. BARKOW und W. WEINITSCHKE, *T. u. F. T.*, 1934, p. 162.

Die technischen Einrichtungen des Fern- und Schnellverkehrs, K. GERBER, *T. u. F. T.*, 1935, p. 43.

Das neue Londoner Fernamt, K. SCHOTTE, *T. u. F. T.*, 1935, p. 70.

Das neue Fernamt in Villach, R. HEIDER, *T. u. F. T.*, 1935, p. 121.

Ausnützung der Fernleitungen bei manuellem und automatischem Betrieb, P. SCHILD, *T. M. schweiz. T. T. V.*, April, 1936.

(c) 4. Apparatus: Repeater Stations.

Verstärkerröhren mit thorierter Wolframkathode, A. GEHRTS, *E. N. T.*, 1925, p. 189.

Grundlagen für die Beurteilung von Fernsprechverstärkern, B. POHLMANN und W. DEUTSCHMANN, *E. N. T.*, 1926, p 8.

Ueber Maximalleistungen von Verstärkerröhren, W. P. RADT, *E. N. T.*, 1926, p. 22.

Stand der Verstärkeramtstechnik, B. POHLMANN, *E. N. T.*, 1926, p. 88.

Ueber die Bemessung von Uebertragern und Entzerrern für Fernsprechzwischenverstärker, R. FELDTKELLER und H. BARTELS, *W. V. S. K.*, vol. VI No. 1, 1927, p. 65.

Ueber rechteckige Verstärkungskurven, R. FELDTKELLER, *W. V. S. K.*, vol. VI, No. 1, 1927, p. 81.

Fernsprechverstärkerämter neuer Bauart, R. ZÜHLKE, *T. u. F. T.*, 1927, p. 9.

Die Entwicklung der Fernsprechverstärker im Jahre 1927 und die Grundlagen des Einheitsverstärkers, H. NOTTEBROCK und R. FELDTKELLER, *T. u. F. T.*, 1927, p. 307.

Vorübertrager verzerrungsfreier Verstärker, R. FELDTKELLER und H. BARTELS, *E. N. T.*, 1929, p. 87.

Ueber die Dynamik der selbsttätigen Verstärkungsregler, K. KÜPFMÜLLER, *E. N. T.*, 1928, p. 459.

Beiträge zur Entwicklung des deutschen Verstärkeramtsbaues, R. ZÜHLKE, *T. u. F. T.*, 1931, p. 76.

Eine selbsttätige Prüf- und Sortiermaschiene für Verstärkerröhren, W. TRAUB und F. MENZLER, *E. T. Z.*, 1931, p. 1277.

Ueber Klangverzerrung und Klirrfaktoren von Verstärkerröhren, A. CLAUSING, *V. G. N.*, 1931, p. 57.

Die Abweichungen der Verstärkerröhren vom $e^{3/2}$-Gesetz, H. KNIEPKAMP, *T. u. F. T.*, 1931, p. 71.

Fernsprech-Verstärkerämter vereinfachter Bauart, A. STRACHE, *T. u. F. T.*, 1932, p. 151.

Neue Formen im Aufbau von Fernsprechverstärkern (Baukastenform), W. RABANUS, *T. u. F. T.*, 1932, p. 188.

Neuzeitliche Verstärker und Stromversorgungsanlagen für Verstärkerämter, V. GANDTNER, *T. u. F. T.*, 1932, p. 311.

10 Jahre Fernkabelverstärkeramtsbau in Deutschland, ZÜHLKE, *E. F. D.*, No. 31, 1933, p. 43.

Neue Formen im Aufbau von Fernsprechverstärkern, K. HÖPFNER, *E. F. D.*, No. 32, 1933, p. 107.

Klirrfaktor und Kennlinie der Verstärkerröhren, A. GEHRTS, *E. N. T.*, 1933, p. 436.

Vierdrahtschnurverstärker, H. DECKER und E. NEUMANN, *E. F. D.*, No. 35, 1934, p. 81.

Fernsprechverstärkerbau nach dem Schienensystem, A. STRACHE, *E. F. D.*, No. 35, 1934, p. 86.

Sondernachbildungen, P. BARKOW uud C. HIRSCHFELDER, *T. u. F. T.*, 1934, p. 239.

Verstärkerämter neuer Bauart in Deutschland, ZÜHLKE, *E. F. D.*, No. 37, 1934, p. 254.

Zur Formverzerrung bei Verstärkerröhren, W. KLEEN, *E. N. T.*, 1934, p. 293.

Messung nichtlinearer Verzerrungen, H. FAULHABER, *E. N. T.*, 1934, p. 351.

Stromversorgungsanlagen für Verstärker- und Trägerfrequenzämter, F. VOGEL und B. FREYSTEDT, *V. G. N.*, 1934, p. 245.

Formverzerrungen durch Verstärkerröhren bei Niederfrequenzverstärkung, A. GEHRTS, *E. F. D.*, No. 40, 1935, p. 155.

Die Entwicklung der Siemens-Fernsprechröhre, C. NEBEL, *V. G. N.*, 1935, p. 215.

Kleine Fernsprech-Verstärkeranlagen, F. VOGEL und H. ROLOFF, *V. G. N.*, 1935, p. 255.

(d) 1. Lines: Open Wire.

None.

(d) 2. Lines: Cables.

Lange Fernsprechseekabel in Leitungen des Weitverkehrs, K. HÖPFNER, *Fk.*, 1923, No. 4, p. 40.

Die Verlegungsarten der europäischen Fernkabel, DEIBEL, *Fk.*, 1923, No. 4, p. 24.

Der Einfluss von Ungleichmässigkeiten im Aufbau von Spulenleitungen auf den Wellenwiderstand, K. W. WAGNER und K. KÜPFMÜLLER, *M. TRA.*, vol. IX, 1923, p. 135, und *A. f. E.*, vol. IX, 1921, p. 461.

Die Arbeiten der deutschen Fernkabelgesellschaft, DEIBEL und MENTZ, *Fk.*, 1924, No. 7, p. 3.

Zur Einführung der Sternverseilung im Fernkabelbau, H. JORDAN, *Fk.*, 1924, No. 10, p. 23.

Fernkabel und Spulen im deutschen Fernkabelnetz, K. DOHMEN, *Fk.*, 1924, No. 7, p. 28.

Weitverkehr im deutschen Fernkabelnetz, K. HÖPFNER, *Fk.*, 1924, No. 5, p. 27.

Die Bauart und technischen Eigenschaften der Fernkabel, K. DOHMEN, *F. i. W.*, 1923, p. 40, und *E. T. Z.*, 1924, p. 89.

Die Entwicklung der Pupinspulen, F. HÖRNING, *F. i. W.*, 1923, p. 66, und *E. T. Z.*, 1924, p. 180.

Ueber die Nachbildung langer Seekabel, H. SALINGER und H. STAHL, *E. N. T.*, 1926, p. 296.

Neue Versuche mit pupinisierten Fernsprechseekabeln, P. CRAEMER und E. MÜLLER, *E. T. Z.*, 1925, p. 1577.

Seekabel im Fernsprechweitverkehr, Ew. MÜLLER, *Fk.*, 1925, No. 9, p. 23.

Grundsätzliches zur Frage des Nebensprechabgleichs, K. DOHMEN und R. DEIBEL, *Fk.*, 1925, No. 9, p. 39.

Weitverkehr über das deutsche Fernkabelnetz, K. HÖPFNER, *E. F. D.*, 1926, No. 1, p. 3.

Ueber den Verwendungsbereich der Vierer nach Dieselhorst-Martin und der Sternvierer, H. W. DROSTE, *Fk.*, 1926, No. 10, p. 16.

Sternkabel (D.-M.-Kabel), F. LÜSCHEN, *Fk.*, 1926, No. 10, p. 29.

Ueber die Wirkung des Pressdrucks auf die Eigenschaften von Massekernen für Pupinspulen, W. EHLERS und F. FALKENBERG, *E. N. T.*, 1926, p. 281.

Ueber die Nachbildung des Scheinwiderstandes von Pupinleitungen unter Berücksichtigung der Amtsschaltungen, R. FELDTKELLER und F. STRECKER, *E. N. T.*, 1927, p. 125.

Ueber Pupinseekabel, K. KÜPFMÜLLER, *E. N. T.*, 1927, p. 359.

Ueber Nachbildungen von Fernsprechkabelleitungen, W. WEINITSCHKE, *T. u. F. T.*, 1927, p. 40.

Ueber ein Endnetzwerk für homogene Fernmeldeleitungen, R. FELDTKELLER, *T. u. F. T.*, 1927, p. 91.

Neue Erfahrungen mit Instandsetzungen und mit der Lebensdauer von Fernsprechseebleikabeln, E. MÜLLER, *E. F. D.*, No. 5, 1927, p. 47.

Ueber die Ortskurven der Scheinwiderstände elektrischer Netzwerke in Abhängigkeit von der Frequenz, F. STRECKER, *W. V. S. K.*, vol. VI, No. 2, 1927, p. 67.

Ueber die Nachbildung des Wellenwiderstandes homogener Leitungen, F. STRECKER, *W. V. S. K.*, vol. VI, No. 1, 1927, p. 88.

Ueber die Nachbildung einer verlustbehafteten Pupinleitung, F. STRECKER und R. FELDTKELLER, *W. V. S. K.*, vol. V, No. 3, 1927, p. 134.

Ueber den Kapazitätsausgleich in Fernsprechkabeln ohne Phantombenutzung, K. DOHMEN und G. PLEUGER, *T. u. F. T.*, 1928, p. 178.

Eine Näherungskonstruktion für eine Nachbildung homogener Leitungen, F. STRECKER, *T. u. F. T.*, 1928, p. 329.

Papierbleikabel für transozeanische Fernsprechverbindungen, K. W. WAGNER und U. MEYER, *E. F. D.*, No. 11, 1929, p. 10.

Doppelsternkabel, K. FISCHER, *E. F. D.*, No. 11, 1929, p. 50.

Auswirkung des neuen Pupinisierungssystems mit erhöhter Grenzfrequenz auf die Bauart der Fernkabel, K. DOHMEN, *E. F. D.*, No. 14, 1929, p. 232.

Das dritte Ostpreussenkabel (1929), E. MÜLLER, *E. F. D.*, No. 14, 1929, p. 234.

Ueber den Klirrfaktor langer Fernkabelleitungen, M. GRÜTZMACHER, *T. u. F. T.*, 1929, p. 143.

Verbesserungen in der Herstellung von Krarupadern, K. Lapkamp, *T. u. F. T.*, 1929, p. 231.

Ueber die Bedeutung der Hysterese bei Pupinspulen, W. DEUTSCHMANN, *E. N. T.*, 1929, p. 80.

Transozeanische Fernsprechkabel, K. W. WAGNER, *E. N. T.*, 1929, p. 125.

Ueber den Flattereffekt bei pupinisierten Leitungen, W. DEUTSCHMANN, *W. V. S. K.*, vol. III, No. 2, 1929, p. 22.

Der Siemens-Kondensatorausgleich für Fernsprechkabel, H. CARSTEN, *S. Z.*, 1929, p. 208.

Die neuen deutschen Normalfernkabel, K. DOHMEN, *E. F. D.*, No. 15, 1930, p. 24.

Drittes Ostpreussenkabel, R. Feist, *E. F. D.*, No. 16, 1930, p. 29.

Das Doppelsternkabel München-Augsburg, K. FISCHER, *E. F. D.*, No. 16, 1930, p. 83.

Das Fernkabel Emden-Groningen, MENTZ, *E. F. D.*, No. 16, 1930, p. 91.

Uebersicht über die Ergebnisse der Reichweitenversuche am Doppelsternkabel München-Augsburg und deren Bedeutung für den Fernsprechweitverkehr im internationalen Netz, Kuno FISCHER, *E. F. D.*, No. 19, 1930, p. 317.

Fortschritte im Fernkabelbau, Karl DOHMEN, *E. F. D.*, No. 20, 1930, p. 376.

Auf dem Wege zum Ozeanfernsprechkabel, Erwin MÜLLER, *E. F. D.*, No. 20, 1930, p. 379.

Ueber Kabelverlegung in Bergstrecken, A. GIEBNER und K. VOISARD, *E. F. D.*, No. 20, 1930, p. 385.

Das dritte Ostpreussenkabel, W. RIHL und E. FISCHER, *S. Z.*, 1930, p. 57.

Das Rundfunkkabel für Bukarest, F. HAAS, *S. Z.*, 1930, p. 57.

Das erste pupinisierte Rundfunkkabel in der U. S. S. R., M. JURJEW, *S. Z.*, 1930, p. 459.

Ueber Materialien mit hoher Anfangspermeabilität, E. GUMLICH, W. STEINHAUS, A. KUSSMANN und B. SCHARNOW, *E. N. T.*, 1930, p. 231.

Ein neues Fernsprechseekabel nach Ostpreussen, FEIST, *T. u. F. T.*, 1930, p. 7.

Ueber lange Fernsprechseekabel und ihre Entwicklung, A. EBELING und K. KÜPFMÜLLER, *E. F. D.*, No. 21, 1931, p. 27.

Das Doppelsternkabel Meppel-Leeuwarden, *E. F. D.*, No. 22, 1931, p. 128.

Das Pupinseekabel Schweden-Gotland 1930, *E. F. D.*, No. 22, 1931, p. 132.

Das Fernsprechkabel Deutschland-Schweden IV, E. MÜLLER und R. FEIST, *E. F. D.*, Nos. 22 und 23, 1931, pp. 93 und 197.

Die Fernsprechkabelanlage zur Zugspitze, Karl BERLING, *E. F. D.*, No. 23, 1931, p. 167.

Die Fernkabellanlage Budapest-Szeged, L. LAZAR, *E. F. D.*, No. 24, 1931, p. 265.

Ueber die Beeinflussung von Kopplungen in Fernsprechkabeln während der Herstellung, O. HAUGWITZ, *E. N. T.*, 1931, p. 49.

Kristallgefüge und Disglomeration des Bleies, Otto HAEHNEL, *E. N. T.*, 1931, p. 77.

Ueber Nebensprechstörungen in Fernsprechkabeln, H. SCHILLER, *E. N. T.*, 1931, p. 114.

Ueber die günstigsten Ausmasse von Pupinspulenkernen, W. DEUTSCHMANN, *T. u. F. T.*, 1931, p. 171.

Längsverteilung kapazitiver Nebensprechkopplungen in Fernsprechkabeln, G. WUCKEL, *E. F. D.*, No. 25-26, 1931, p. 324.

Ueber die Beseitigung von Störgeräuschen in beeinflussten Fernsprechkabelleitungen, H. JORDAN, *E. N. T.*, 1931, p. 421.

Der Doppelerdschlussstrom in Drehstromkabeln und seine Einwirkung auf benachbarte Fernmeldekabel, W. WILD, *W. V. S. K.*, vol. X, 1931, p. 51.

Ueber die magnetischen Eigenschaften der Perminvare, H. KÜHLEWEIN, *W. V. S. K.*, vol. X, 1931, p. 72.

Ueber Kopplungsänderungen in Fernsprechkabeln, A. FORSTMEYER und G. PLEUGER, *E. F. D.*, No. 28, 1932, p. 108.

Aufbau, Bezeichnungsweise und elektrische Werte neuzeitlicher Fernkabel in Deutschland, K. DOHMEN, *E. F. D.*, No. 28, 1932, p. 117.

Neuzeitliche Pupinspulen des deutschen Fernkabelnetzes, K. DOHMEN, *E. F. D.*, No. 29, 1932, p. 182.

Das Fernsprechkabel Deutschland-Dänemark IV, E. MÜLLER, *E. F. D.*, No. 29, 1932, p. 188.

Die Grundzüge des allgemeinen Fernleitungsplans, H. F. MAYER, *E. F. D.*, No. 30, 1932, p. 238.

Systematische oder zufallsmässige Längsverteilung der Nebensprechkopplungen in Sternkabeln? G. WUCKEL, *E. F. D.*, No. 30, 1932, p. 256.

Fernkabelmesswagen, A. MENTZ, *E. F. D.*, No. 30, 1932, p. 260.

Ueber Nebensprechstörungen in Fernsprechkabeln, H. SCHILLER, *E. N. T.*, 1932, p. 81.

Eigenartige Korrosionen auf der Innenseite der Mäntel von Fernsprechbleikabeln, O. HAEHNEL und H. KLEWE, *E. N. T.*, 1932, p. 407.

Untersuchungen über die Ursachen von Nebensprechstörungen in Fernsprechkabeln, H. FEINER, *E. N. T.*, 1932, p. 412.

Die Teilerdkopplungen als Gradmesser für die Herstellungsgüte von Fernsprechkabeln, G. WUCKEL, *E. N. T.*, 1932, p. 455.

Die katalytische Wirkung des Phenols bei der Korrosion von Bleikabeln, E. DA FANO, *T. u. F. T.*, 1932, p. 267.

Versuche am Seekabel Stralsund-Malmö, R. WINZHEIMER, Th. BAUM und W. OESER, *T. u. F. T.*, 1932, p. 91.

Viertes deutsch-dänisches Fernsprechkabel, R. FEIST, *T. u. F. T.*, 1932, p. 44.

Der Mantelschutzfaktor von Fernmeldekabeln, A. ZASTROW und W. WILD, *E. N. T.*, 1932, p. 10.

Ueber Massekerne, W. DEUTSCHMANN, *E. N. T.*, 1932, p. 421.

Form und Einrichtung der Pupinspulenkasten im deutschen Fernkabelnetz, K. DOHMEN, *E. F. D.*, No. 31, 1933, p. 35.

Ueber Insekten, die Bleimäntel von Luftkabeln durchbohren, O. HAEHNEL, *E. F. D.*, No. 33, 1933, p. 180.

Die Rückwirkung metallischer Spulenkapseln auf Verluste, Induktivität, und Aussenfeld einer Spule, H. KADEN, *E. N. T.*, 1933, p. 277.

Neuartige magnetische Werkstoffe für Pupinspulen, O. DAHL, J. PFAFFENBERGER und H. SPRUNG, *E. N. T.*, 1933, p. 317.

Das Gegenkopplungskabel-Verfahren, ein neues Verfahren zum Ausgleich von Teilkapazitätsunsymmetrien der Adergruppen von Fernmeldekabeln, H. DROSTE, *E. N. T.*, 1933, p. 425.

Ueber Erfahrungen an einer im "Gegenkopplungskabel-Verfahren" ausgeglichenen Bezirkskabelanlage, K. SIEBER, *E. N. T.*, 1933, p. 429.

Kabelkanäle nach Burmeister, P. Kleinsteuber, *T. u. F. T.*, 1933, p. 71.

Zur Frage des Erdausgleichs in starkstrombeeinflussten Fernsprechkabeln, H. KARSTEN und G. v. SUSANI, *V. G. N.*, 1933, p. 101.

Pupinspulen mit Kernen aus Isoperm-Blech oder-Band, H. JORDAN, Th. VOLK und R. GOLDSCHMIDT, *E. F. D.*, No. 31, 1933, p. 8.

Objektive Nebensprechmessung, K. MITTELSTRASS, *T. u. F. T.*, 1933, p. 245.

Die Wirtschaftlichkeit im Fernkabelbau, A. MENTZ, *E. F. D.*, No. 34, 1934, p. 10.

Enstehung und Wesen der magnetischen Nebensprechkopplungen in Fernsprechkabeln, G. WUCKEL, *E. F. D.*, No. 34, 1934, p. 18.

Grundsätzliches über elektromagnetische Kopplungen zwischen parallelen Leitungen, K. W. WAGNER, *E. F. D.*, No. 36, 1934, p. 147.

Neuere Entwicklung in der Herstellug von Fernsprechkabeln auf physikalischer Grundlage., G. WUCKEL, *E. F. D.*, No. 36, 1934, p. 157.

Beitrag zur Theorie des Aufbaus störungsarmer Fernsprechkabel, K. SIEBER und K. SCHLUMP, *E. N. T.*, 1934, p. 119.

Komplexe magnetische Nebensprechkopplungen in Fernsprechkabeln, G. WUCKEL, *E. N. T.*, 1934, p. 157.

Mehrteilige Kabelformstücke, P. KLEINSTEUBER, *T. u. F. T.*, 1934, p. 13.

Technik und Wirtschaftlichkeit des Ausgleichs in Fernsprechkabeln, K. DOHMEN und G. PLEUGER, *E. F. D.*, No. 37, 1934, p. 219.

Umgestaltung des reichsdeutschen Fernsprechnetzes im Bodenseegebiet, E. MÜLLER, *E. F. D.*, No. 37, 1934, p. 235.

Zur Elektrodynamik des Runddrahts mit Eisenmantel (Krarupader), J. FISCHER, *E. N. T.*, 1934, p. 140.

Physikalische Probleme im Rahmen der neuesten Entwicklung der Fernkabeltechnik, G. WUCKEL, *E. T. Z.*, 1934, p. 1166.

Kabelfehler und ihre Ursachen, R. GERTSCH, *T. M. schweiz. T. T. V.*, Feb. 1934.

Physikalische Untersuchungen an neuen magnetischen Werkstoffen, M. KERSTEN, *Z. f. t. P.*, 1934, p. 249.

Phantompupinisierte Sternvierer, H. JORDAN und W. WOLFF, *E. F. D.*, No. 39, 1935, p. 85.

Der Ersatz von Zinn in Bleikabelmänteln durch geringe Mengen Tellur, KRÖNER, *E. N. T.*, 1935, p. 113.

Breitbandkabel mit neuartiger Isolation, H. F. MAYER und E. FISCHER, *E. T. Z.*, 1935, p. 1245.

Ueber die Enstehung von Längsrissen in Kabelbleimänteln und andere, in den Fachzeitschriften bisher noch nicht beschriebene Mantelschäden, O. HÄEHNEL, *T. u. F. T.*, 1935, p. 179.

Ueber die Wiener Fernsprechkabelanlage und ihre Entwicklung in den Jahren 1923 bis 1932, H. JOKISCH und A. STEMPKOWSKI, *T. u. F. T.*, 1935, p. 305.

Hochfrequenzkabel, W. KIESER, *Z. f. t. P.*, 1935, p. 629, und *E. F. D.*, No. 43, 1936, p. 85.

Verlegung von Fluss- und Seekabeln durch Einspülen, K. HESSE, *E. T. Z.*, 1936, p. 578.

(d) 3. Lines: Mixed Cable and Open Wire Lines.

Ueber Schaltungen zur Verbindung von homogenen und pupinisierten Leitungen, F. STRECKER und R. FELDTKELLER, *W. V. S. K.*, vol. VI, No. 2, 1927, p. 127.

Die Eingliederung der oberirdischen Fernleitungen in das deutsche Fernleitungsnetz, W. WEINITSCHKE, *T. u. F. T.*, 1932, p. 207.

(e) Line Maintenance.

Die Messung der dielektrischen Ableitungen und Kapazitäten mehradriger Kabel mit Wechselstrom, K. W. WAGNER, *E. T. Z.*, 1912, p. 635.

Praktische Vereinfachung der Ortsbestimmung von Ungleichheiten in den Spulenfeldern der Pupinkabel, D. WEHAGE, *M. TRA.*, vol. XI, 1926, p. 117, und *T. u. F. T.*, No. 11, 1924, p. 185.

Ueber die Ortsbestimmung eines allgemeinen Isolationsfehlers in einem Fernsprechkabel, K. KÜPFMÜLLER, *T. u. F. T.*, 1925, p. 234.

Messung der Differenzen der Erdkapazitäten in viererverseilten Fernkabeln, D. WEHAGE, *Fk.*, 1924, No. 6, p. 29, und *M. TRA.*, vol. X, 1925, p. 337.

Fernkabelmesszug, A. MENTZ, *Fk.*, 1926, No. 10, p. 11.

Die Messung des Nebensprechens, U. MEYER, *T. u. F. T.*, 1926, p. 1.

Prüfungen und Messungen zur Unterhaltung der Fernkabelleitungen mit Verstärkern von den Endanstalten aus, K. HÖPFNER, *E. F. D.*, 1926, No. 2, p. 24.

Verfahren für Verstärkermessungen mit wissenschaftlicher Begründung, H. SCHULZ, *M. TRA.*, 1926, p. 185, und *T. u. F. T.*, 1925, p. 29.

Der Pegelzeiger, H. F. MAYER, *E. N. T.*, 1927, p. 379.

Eine Messeinrichtung für betriebsmässige Verstärkungsmessungen bei Verstärkerämtern, G. GRIMSEN, *T. u. F. T.*, 1927, p. 49.

Fernkabelleitungen und ihre Ueberwachung, W. RABANUS, *T. u. F. T.*, 1928, p. 1.

Ueber die Messung der Echodämpfung, R. FELDTKELLER und H. JACOBY, *T. u. F. T.*, 1928, p. 61.

Verfahren zum Messen von Betriebsdämpfungen und Verstärkungen, W. WEINITSCHKE, *T. u. F. T.*, 1928, p. 359.

Der Messschrank für Fernkabelleitungen, W. GEBHARDT und P. RICHTER, *T. u. F. T.*, 1928, No. 11, Sonderbeilage.

Mehrfache elektrische Schwingungserzeuger mit bequemer Regulierung der gemeinsamen Frequenz und der gegenseitigen Phase und Amplitude, W. GRÖSSER, *W. V. S. K.*, vol. VIII, No. 2, 1929, p. 14.

Die Pfeifsicherheit von Einrohrverstärkern in Schnellverkehrsleitungen, W. WEINITSCHKE, *T. u. F. T.*, 1929, p. 388.

Die selbsttätige Regelung des Puffer-und Ladestroms, LOOG, *T. u. F. T.*, 1930, p. 35.

Kabelsuchgeräte, *T. u. F. T.*, 1930, p. 308.

Fehlerortsbestimmung bei Kabeladerbrüchen, G. PLEUGER und A. VOLLMEYER, *T. u. F. T.*, 1930, p. 312.

Zur Theorie der Tonfrequenzmessgeräte mit Trockengleichrichtern, R. FELDTKELLER und KERSCHBAUM, *T. u. F. T.*, 1930, p. 333.

Messung der Frequenzcharakteristik mit Hilfe des Lichttongenerators, W. SCHAEFFER und G. LUBSZYNSKI, *E. N. T.*, 1931, p. 213.

Ueber den Scheinwiderstand von Spulenleitungen mit einer teilweise oder zur Gänze unwirksamen Spule, E. ADAM, *E. N. T.*, 1931, p. 404.

Ueber eine Messbrücke zur Bestimmung des Fehlerortes bei Aderbrüchen in Kabeln, H. CARSTEN und G. v. SUSANI, *T. u. F. T.*, 1931, p. 35.

Fehlersuchen mit Kabelsuchgerät, *T. u. F. T.*, 1931, p. 47.

Untersuchungen über die Pfeifbedingungen des Zweidrahtverstärkers und ihre Auswertung für ein neues Verstärkungsmessverfahren, W. WEINITSCHKE, *T. u. F. T.*, 1931, p. 303.

Ein Fernsprech-Arbeitseichkreis, C. HARTMANN und E. DÖRING, *E. N. T.*, 1931, p. 444.

Die Anwendung des Trockengleichrichters in der Tonfrequenzmesstechnik, W. WOLMAN und H. KADEN, *Z. f. t. P.*, 1931, p. 470.

Frequenzabhängige Echodämpfungsmessungen an Leitungen nach dem Pfeifpunktmessverfahren und ihre Anwendung zur Bestimmung der Lage, Art und Grösse eines Leitungsfehlers, W. WEINITSCHKE, *T. u. F. T.*, 1932, p. 36.

Ein neues Verfahren für das Prüfen und Herstellen von Leitungsnachbildungen im Zweidrahtbetrieb, W. WEINITSCHKE, *T. u. F. T.*, 1932, p. 100.

Ueber die Frequenzentzerrung von Messgeräten mit Trockengleichrichtern, H. KADEN, *E. N. T.*, 1932, p. 175.

Die Anwendung der Gleichrichterbrücke in der Messtechnik, C. WALTER, *Z. f. t. P.*, 1932, p. 436.

Die schreibenden Messgeräte (Pegelschreiber) und ihre Verwendung im Betrieb der Deutschen Reichspost. H. RIBBECK und F. WIEDEMANN, *E. F. D.*, No. 32, 1933, p. 85.

Unterhaltung der Fernkabellinien, A. MENTZ, *E. F. D.*, No. 33, 1933, p. 162.

Ueber den Scheinwiderstand von fehlerhaften Spulenleitungen, insbesondere mit abweichender Betriebskapazität in einem Spulenfelde, E. ADAM und F. HAAS, *E. N. T.*, 1933, p. 109.

Neue Impuls-Messgeräte, Laboratorium der Hasler A. G., *T. M. schweiz. T. T. V.*, April, 1933.

Die Anwendungsgebiete des Pegelschreibers in der Fernmeldetechnik, L. FENYÖ, *T. u. F. T.*, 1933, p. 3 und p. 36.

Neuzeitliche Messungen an Fernsprechleitungen, F. VOGEL und U. HENNECKE, *V. G. N.*, 1933, p. 67.

Ein Messgerät grossen Bereiches für induktive, kapazitive und reelle Kopplungen, A. WIRK, *T. u. F. T.*, 1933, p. 144.

Dämpfungszeiger und Milliwattsender für betriebsmässige Messungen, P. JUST, *T. u. F. T.*, 1934, p. 215.

Eine neue Brücke für betriebsmässige Messungen von Wechselstromwiderständen nach Betrag und Phase, M. GRÜTZMACHER, *T. u. F. T.*, 1934, p. 27.

Neuzeitliche Messungen an Trägerfrequenzverbindungen auf Freileitungen, F. VOGEL und B. FREYSTEDT, *V. G. N.*, 1934, p. 79.

Ein billiger Netzanschluss-Schwebungssummer, H. THILO und C. v. RIML, *V. G. N.*, 1934, p. 119.

Ueber die Messung kleinster Winkeldifferenzen von Scheinwiderständen, A. WIRK, *E. N. T.*, 1934, p. 61.

Ueber die nichtlinearen Verzerrungen von Ferrocart und über eine neue, einfache Methode zur Bestimmung der nichtlinearen Verzerrungen von Zweipolen, H. FAULHABER, *E. N. T.*, 1934, p. 289.

Neue Prüfgeräte für die Fernmeldetechnik, *S. Z.*, 1934, p. 249.

Technische Hilfsmittel zur Ueberwachung der Orts-Fernsprechnetze und Sprechstellen, P. JUST, *E. F. D.*, No. 38, 1935, p. 47.

Ein neues Verfahren zur Bestimmung des Ortes einer fehlerhaften Pupinspule oder einer unregelmässigen Feldkapazität bei Pupinleitungen, E. WILD, *E. F. D.*, No. 40, 1935, p. 108.

Fehlerstatistik für das schwedische Stammkabelnetz, S. NORDSTRÖM, *E. F. D.*, No. 40, 1935, p. 173.

Eine nichtelektrische Methode zur Bestimmung von Bleimantelfehlern in Telephonkabeln, K. BUSS und W. VOGEL, *E. F. D.*, No. 41, 1935, p. 235.

Die Messfrequenzmaschine TMM 33 der Deutschen Reichspost, K. GÜNTHER, *T. u. F. T.*, 1935, p. 142.

Ein neuartiger Messkoffer für Fernmeldeanlagen, H. THILO und M. BIDLINGMAIER, *T. u. F. T.*, 1935, p. 66.

Ueber die Grenzen der Analysiergeschwindigkeit bei Frequenzgemischen, C. WALTER, *V. G. N.*, 1935, p. 31.

Ueber einen schreibenden Frequenzanalysator, C. WALTER und E. FREYSTEDT, *V. G. N.*, 1935, p. 51.

Der Betrieb von Messeinrichtungen mittels Wechselstromnetzanschluss, F. VOGEL und B. FREYSTEDT, *V. G. N.*, 1935, p. 67.

Ueber Messungen an technischen Verstärkerröhren, F. VOGEL und G. KUBE, *V. G. N.*, 1935, p. 109.

Tonfrequenzgeneratoren für Messzwecke, R. TAMM und U. HENNECKE, *V. G. N.*, 1935, p. 127.

Das "Tonfrequenz-Spektrometer," eine Frequenzanalysator mit äusserst hoher Analysiergeschwindigkeit und unmittelbar sichtbarem Spektrum, E. FREYSTEDT, *Z. f. t. P.*, 1935, p. 533.

Wechselstromverfahren zur Bestimmung des Ortes von Paarzerreissungen in Fernsprechkabeln, E. WIDL und F. DERFLER, *E. T. Z.*, 1936, p. 409.

Das Kabelsuchgerät und seine Anwendung, W. GRAF, *T. u. F. T.*, 1936, p. 66.

Verzerrungsmessplatz für Rundfunkleitungen, E. FREYSTEDT und W. LANGSDORFF, *T. u. F. T.*, 1936, p. 79.

Neuzeitliche Tonfrequenzmessgeräte mit Netzanschluss, H. THILO, *V. G. N.*, 1936, p. 13.

Der Kupferoxydul-Gleichrichter in der Messtechnik, R. TAMM und F. BATH, *V. G. N.*, 1936, p. 51.

Kleiner Messpegelplatz mit Netzanschluss, F. VOGEL und U. HENNECKE, *V. G. N.*, 1936, p. 89.

Messplätze für die Fernmeldetechnik F. VOGEL und K. SCHLUPP, *V. G. N.*, 1936, p. 97.

Anzeigende Ueberwachungsgeräte für Rundfunkübertragungen, H. LIERSCH, *V. G. N.*, 1936.

(f) Simultaneous or Co-existing Telegraphy and Telephony.

Tonfrequenzwechselstromtelegraphie, F. LÜSCHEN, *E. T. Z.*, 1923, p. 1 et p. 28.

Die Technik der Telegraphie und Telephonie im Weitverkehr, F. LÜSCHEN, *E. T. Z.*, 1924, p. 793.

Stand der Tonfrequenz-Mehrfachtelegraphie, A. CLAUSING, *E. T. Z.*, 1926, p. 500.

Funkbild-Uebertragung im Anschluss an Rundfunk-Gerät, M. DIECKMANN, *E. N. T.*, 1926, p. 201.

Ueber die Wahl der Trägerfrequenzen für die Tonfrequenztelegraphie, F. LÜSCHEN und K. KÜPFMÜLLER, *E. N. T.*, 1927, p. 165.

Wodurch wird die Telegraphiergeschwindigkeit bestimmt ? H. SALINGER, *E. F. D.*, Sonderheft "Como," 1927, p. 46.

Ein neues System für Wechselstrommehrfachtelegraphie, M. WALD, *E. N. T.*, 1928, p. 391.

Das A. E. G.—Vielfachträgerstromtelegraphie-System mit Sprachfrequenzen für Fernsprechkabel, K. WEDLER, *T. u. F. T.*, 1929, p. 159.

Die Ausnutzungsmöglichkeiten einer Fernkabelader für Telegraphie, H. STAHL, *T. u. F. T.*, 1929, p. 95.

Versuche über eine günstigste Verteilung der Trägerwellen in der Wechselstromtelegraphie, H. STAHL, *T. u. F. T.*, 1930, p. 340.

Das Fernschreibnetz des Siemens-Konzerns, A. JIPP, *S. Z.*, vol. XI, 1931, p. 236.

Elektrodynamischer Bandverstärker als Ersatz für Siebketten und Röhrenverstärker bei Tonfrequenztelegraphie, M. Wald, *E. N. T.*, 1932, p. 91.

Ist die Fernsprechteilnehmer-Telegraphie ein Ersatz für ein Teilnehmerfernschreiben auf Telegraphenleitungen ? H. SCHULZ und H. STAHL, *T. u. F. T.*, 1933, p. 203.

Ueberlagerungstelegraphie auf Fernsprechleitungen (UT), W. HAEHNLE und H. NOACK, *T. u. F. T.*, 1933, p. 303.

Die Mehrfachwechselstromtelegraphie (WT), A. ARZMAIER und A. EBERT, *T. u. F. T.*, 1934, p. 107.

Die Fortentwicklung des Fernschreibverkehrs über Draht und drahtlos, P. STORCH, *E. T. Z.*, 1934, p. 109 und p. 141.

Die Eintontelegraphie, A. ARZMAIER und H. RUDOLPH, *T. u. F. T.*, 1935, p. 245.

Ueber Versuche und Erfahrungen mit Ueberlagerungstelegraphie auf Fernsprechfernleitungen, H. NOACK und W. SCHALLERER, *T. u. F. T.*, 1935, p. 316.

(g) Co-ordination of Radiotelephony and Telephony.

Fernsprechverkehr zwischen Deutschland und Nordamerika, K. HÖPFNER, *T. u. F. T.*, 1928, p. 98.

Die Fernsprechverbindung zwischen Europa und Amerika, E. WOLLNER, *E. N. T.*, 1928, p. 489.

Ueber die Akustik von Studioräumen, W. FURRER, *T. M. schweiz. T. T. V.*, April, June 1936.

II. PUBLICATIONS IN ENGLISH.

(a) 1. General : Transmission Standards and Definitions.

Condenser Microphones, W. WEST ; *J. I. E. E.*

The Determination of Resonant Frequencies and Decay Factors, Prof. E. MALLETT ; *J. I. E. E.*, 1924, p. 517.

Telephonometry, B. S. COHEN ; *I. P. O. E. E.* paper No. 70.

The Transmission Unit, R. V. L. HARTLEY ; *Elec.*, No. 94, pp. 58-59 (16th Jan. 1925) and pp. 93-94 (23rd Jan. 1925).

A High Quality Telephone Transmission System, B. S. COHEN ; *P. O. E. E. J.*, vol. XIX, Part 3 (1926).

Calibration of Wente condenser transmitter, A. J. ALDRIDGE ; *P. O. E. E. J.*, Oct. 1928.

Articulation and intelligibility of a telephone circuit, COLLARD ; *El. Com.*, Jan. 1929.

Decibel—the name for the transmission unit, W. H. MARTIN ; *J. A. I. E. E.*, 1929, p. 223, and *B. S. T. J.*, Jan. 1929.

The Frequency of Occurrence of Speech Sounds in Spoken English, Norman R. FRENCH and Walter KOENIG, Jr. ; *J. A. S. A.*, 1929, p. 110.

The Words and Sounds of Telephone Conversations, Norman R. FRENCH, Charles W. CARTER, Jr., and Walter KOENIG, Jr., *J. A. S. A.*, Oct. 1929.

The Unit of Transmission and the Transmission Reference System, G. H. GRAY ; *El. Com.*, July 1929.

Master Reference System for Telephone Transmission, W. H. MARTIN and C. H. G. GRAY ; *B. S. T. J.*, 1929, p. 536.

The Calculation of the Articulation of a Telephone Circuit from the Circuit Constants, J. COLLARD ; *El. Com.*, Jan. 1930.

An Improved Condenser Microphone for Sound Pressure Measurements, D. A. OLIVER ; *Journal of Scientific Instruments*, April 1930.

The Pressures on the Diaphragm of a Condenser Transmitter in a Simple Sound Field, W. WEST ; *J. I. E. E.*, 1930.

Effect of noise on the articulation of a telephone circuit, J. COLLARD ; *P. O. E. E. J.*, Oct. 1930.

Room noise in telephone locations, W. J. WILLIAMS and R. G. McCURDY ; *B. S. T. J.*, Oct. 1930.

Microphonic action in telephone transmitters, F. S. GOUCHER ; *Science*, 14th Nov. 1930.

Absolute Calibration of Condenser Transmitters, L. J. SIVIAN ; *B. S. T. J.*, Jan. 1931, pp. 96-115.

Rating Transmission Performance of Telephone Circuits, W. H. MARTIN ; *B. S. T. J.*, Jan. 1931.

Frequency Characteristics of Standard Reference type Condenser Transmitters and Moving Coil Receivers, W. WEST, *P. O. E. E. J.*, April 1931.

Condenser and carbon microphones, W. C. JONES ; *B. S. T. J.*, Jan. 1931.

Audible frequency ranges of music, speech and noise W,. B. SNOW ; *J. A. S. A.*, July 1931, pp. 155-166.

An Automatic Device for Recording, Correcting, and Analysing Articulation Results, J. COLLARD ; *El. Com.*, Jan. 1932.

A Voice and Ear for Telephone Measurements, A. H. INGLIS, C. H. G. GRAY, et R. T. JENKINS ; *B. S. T. J.*, April 1932.

An Efficient Miniature Condenser Microphone System, H. C. HARRISON and P. B. FLANDERS; *B. S. T. J.*, July 1932.

The Lapel Microphone, W. C. JONES and D. T. BELL; *J. S. M. P. E.*, Sept. 1932.

Room Noise and Reverberations as Problems in Telephony, W. WEST; *I. P. O. E. E.*, paper No. 145.

A New Criterion of Circuit Performance, J. COLLARD; *El. Com.*, April 1933.

On Minimum Audible Sound Fields, L. J. SIVIAN and S. D. WHITE; *J. A. S. A.*, April 1933.

Developments in the Application of Articulation Testing, T. J. CASTNER and C. W. CARTER, Jr.; *B. S. T. J.*, July 1933.

A System of Effective Transmission Data for Rating Telephone Circuits, F. W. McKOWN and J. W. EMLING, *B. S. T. J.*, July 1933.

Transmission Loss through Partition Walls, E. H. BEDELL and K. W. SWARTZEL, Jr.; *J. A. S. A.*, July 1933.

Some Theoretical and Practical Aspects of Noise Induction, R. F. DAVIS and H. R. HUNTLEY; *B. S. T. J.*, Oct. 1933.

Loudness, Its Definition, Measurement and Calculation, H. FLETCHER and W. A. MUNSON, *J. A. S. A.*, Oct. 1933, and *B. S. T. J.*, Oct. 1933.

Auditory Perspective-Symposium, *El. Eng.*, June 1934, and *B. S. T. J.*, April 1934.

Some Acoustical Aspects of Telephony, E. G. RICHARDSON; *P. O. E. E. J.*, April 1934.

The Practical Application of the New Unit of Circuit Performance, J. COLLARD; *El. Com.*, April 1934.

A device for measuring sound pressure in free air, W. WEST; *P. O. E. E. J.*, vol. 26, 1934.

(a) 2. General: Recommendations of Principle.

Telephone Transmission, J. E. STATTERS; *I. P. O. E. E.*, paper No. 101.

The Nature and Reproduction of Speech Sounds (Vowels), Sir Richard PAGET; *J. I. E. E.*, 1924, p. 963.

Some Artificial Lines and Networks associated with the Uniform Telephone Transmission Line; *J. I. E. E.*, 1925, p. 593.

The Design of filters for audio-frequencies, C. A. BEER and G. J. S. LITTLE; *P. O. E. E. J.*, 1925, vol. XVII, Part 4.

Rigorous and approximate Theories of electrical transmission, J. R. CARSON; *B. S. T. J.*, 1928, p. 11.

Phase distortion and phase distortion correction, MEAD; *B. S. T. J.*, April 1928.

Present Status of wire transmission theory and some of its outstanding problems, J. R. CARSON; *B. S. T. J.*, 1928; p. 268.

Distortion correction in electrical circuits with constant resistance recurrent networks, Otto J. ZOBEL; *B. S. T. J.*, 1928, p. 438.

Harmonic production in ferromagnetic materials at low frequencies and low flux densities, PETERSEN; *B. S. T. J.*, Oct. 1928.

Long distance cable telephony, ERIKSON; *Elec.*, 1928, pp. 178 and 242.

Distortion in irregularly loaded lines, WARREN; *J. I. E. E.*, June 1928.

Relation between transmission line insulation and transformer insulation, W. W. LEWIS; *J. A. I. E. E.*, 1928, p. 637.

Rationalization of transmission system insulation strength, Philip SPORN; *J. A. I. E. E.*, 1928, p. 641.

Arrival Curves and Theoretical Speeds (Some notes on), PALMER and JOSEPHS; *P. O. E. E. J.*, Oct. 1928.

Audio Frequency Transformers P. KLEV, Jr., and D. W. SHIRLEY; *J. A. I. E. E.*, 1929.

The graphic solution of A. C. transmission line problems, F. M. DENTON; *J. A. I. E. E.*, 1929, p. 49.

The Theory of Electrical Conductivity, W. V. HOUSTON; *J. A. I. E. E.*, 1929.

Operational Methods in Wire Transmission Theory, JOSEPHS; *P. O. E. E. J.*, April 1930.

Determination of the desirable Attenuation-Frequency Characteristics of a Long Toll Circuit, A. R. A. RENDALL; *El. Com.*, April 1930.

Telephone Transmission Networks, Types and Problems of Design, T. E. SHEA and C. E. LANE; *J. A. I. E. E.*, Aug. 1930.

Transmitted Frequency Range For Telephone Message Circuits, W. H. MARTIN; *B. S. T. J.*, 1930.

Wave propagation over continuously loaded fine wires, M. K. ZINN; *B. S. T. J.*, Jan. 1930.

Impedance Correction of Wave Filters, E. B. PAYNE, *B. S. T. J.*, Oct. 1930.

A Method of Impedance Correction, H. W. BODE; *B. S. T. J.*, Oct. 1930.

Sinusoidal currents in linearly tapered, loaded transmission lines, J. W. ARNOLD and P. F. BECHBERGER; *Pr. I. R. E.*, Feb. 1931.

Outline notes on telephone transmission theory, W. T. PALMER, *P. O. E. E. J.*, vol. 23, Oct. 1930; Jan. 1931, vol. 24; April 1931, July 1931, Oct. 1931, Jan. 1932.

Condenser and Carbon Microphones, W. C. JONES; *B. S. T. J.*, Jan. 1931.

A Magnetic Curve Tracer, F. E. HAWORTH; *B. S. T. J.*, Jan. 1931.

Extensions to the Theory and Design of Electric Wave Filters; O. J. ZOBEL; *B. S. T. J.*, April 1931.

The Statistical Energy-Frequency Spectrum of Random Disturbance, John R. CARSON; *B. S. T. J.*, July 1931.

Physical Characteristics of Speech & Music, Harvey FLETCHER; *B. S. T. J.*, July 1931.

Annual Report of Committee on Communications, *J. A. I. E. E.*, July 1931; part 2, pp. 550-556.

The Practical Value of the Proximity Loss in Parallel Go and Return Conductors, J. K. WEBB; *El. Com.*, July 1931.

World Wide Telephony, Its Problems and Future, B. GHERARDI and F. B. JEWETT; *B. S. T. J.*, Oct. 1932.

Probability Theory and Telephone Transmission Engineering, R. S. HOYT; *B. S. T. J.*, Jan. 1933.

Two Aids in the Study of Telephone Transmission, A. K. ROBINSON; *P. O. E. E. J.*, Oct. 1933.

Effects of Rectifiers on System Wave Shape, P. W. BLYE and H. E. KENT; *El. Eng.*, Jan. 1934.

A General Theory of Electric Wave Filters, H. W. BODE; *B. S. T. J.*, April 1935.

Ideal Wave Filters, H. W. BODE et R. L. DIETZOLD; *B. S. T. J.*, April 1935.

Ferromagnetic Distortion of a Two-Frequency Wave, Robert M. KALB and William R. BENNETT; *B. S. T. J.*, April 1935.

Thermionic Electron Emission, J. A. BECKER; *B. S. T. J.*, July 1935.

Improvements in Communication Transformers, A. G. GANZ and A. G. LAIRD; *El. Eng.*, December, 1935; *B. S. T. J.*, Jan. 1936.

The Present Status of Ferromagnetic Theory, R. M. BOZORTH; *B. S. T. J.*, Jan. 1936.

Magnetic Alloys of Iron, Nickel, and Cobalt, G. W. ELMEN; *El. Eng.*, Dec. 1935; *B. S. T. J.*, Jan. 1936.

The Proportioning of Shielded Circuits for Minimum High-Frequency Attenuation, E. I. GREEN, F. A. LIEBE and H. E. CURTIS; *B. S. T. J.*, April 1936.

(b) 1. General Rules concerning Transmission Systems for Ordinary Telephony.

Telephone circuit unbalances, FERRIS and MCCURDY; *B. repr.*, B. 134.

Applied Telephone Transmission, J. S. ELSTON; *I. P. O. E. E.*, paper No. 88.

Transmission of information, R. V. L. HARTLEY; *B. S. T. J.*, 1928, p. 535.

Telephone Toll plant in the Chicago Region, G. B. WEST; *J. A. I. E. E.*, 1928, p. 43.

Recent Developments in Telephone Construction Practices, B. S. WAGNER and A. C. BURROWAY; *J. A. I. E. E.*, vol. 48, May 1929.

Meeting Long Distance Telephone Problems, H. R. FRITZ and H. P. LAWTHER, Jr.; *J. A. I. E. E.*, July 1929.

Developments in Communication Materials, W. FONDILLER; *J. A. I. E. E.*, Nov. 1929.

Report of Committee on Electrical Communication, H. W. DRAKE, president; *J. A. I. E. E.*, 1929.

Telephone Communication System of the United States, Bancroft GHERARDI and F. B. JEWETT; *B. S. T. J.*, 1930, p. 1.

A General Switching plan for telephone toll service, H. S. OSBORNE; *B. S. T. J.*, July 1930, p. 429.

Development of the telephone system, A. J. PRATT; *J. I. E. E.*, Dec. 1930.

Toll Switching Plan for Wisconsin, W. C. LALLIER; *J. A. I. E. E.*, Sept. 1932.

Technical Advances in Long Distance Cable Telephony, P. E. ERIKSON; *El. Com.*, Jan. 1934.

Recent developments in Long Distance Telephony, A. C. TIMMIS; *J. I. E. E.*, vol. 78, 1936.

(b) 2. General Rules concerning Transmission Systems for Carrier Telephony.

Some Experiments on Carrier Current Telephony, C. A. TAYLOR and R. BRADFIELD; *I. P. O. E. E.* paper No. 86.

Approximate networks of acoustic filters, MASON; *B. repr.*, B. 493.

Carrier-Current Communications, B. R. CUMMINGS; *G. E. R.*, No. 29, May 1926.

Carrier current communication on submarine cables, HITCHCOCK; *J. A. I. E. E.*, Oct. 1926.

Carrier Telephony on high-voltage power lines, WOLFE; *B. repr.*, B. 116.

The C-2-F Carrier system, JAMMER; *El. Com.*, July 1928.

Carrier Current telephony on power lines in Southern California, ASHBROOK and HENRY; *El. Rev.*, 18 May, 1928.

Power Line carrier telephony, L. F. FULLER and W. A. TOLSON; *J. A. I. E. E.*, 1928, p. 711.

Problems in power line carrier telephony, W. V. WOLFE and J. D. SARROS; *J. A. I. E. E.*, 1928, p. 727.

Carrier telephone systems in Australia, PARTINGTON; *P. O. E. E. J.*, Oct. 1928.

Single side-band carrier on power lines, WILKINS and LAWSON; *El. W.*, 3 Nov. 1928.

Carrier Current telephony, TIMMIS; *P. O. E. E. J.*, Jan. 1929.

Carrier Telephone Systems, A. J. H. LLOYD, *M. Eng.*; *J. I. E. E.*, 1929.

Carrier systems on long distance telephone lines, H. A. AFFEL, C. S. DEMAREST and C. W. GREEN; *J. A. I. E. E.*, Jan. 1929, et *B. S. T. J.*, 1928, p. 564.

Carrier current telephone system for short toll circuits, BLACK, ALMQUIST and ILGENFRITZ; *J. A. I. E. E.*, Jan. 1929.

Shielding in High Frequency Measurements, John G. FERGUSON; *J. A. I. E. E.*, 1929.

The Transmission of high frequency currents for communication over existing power networks, C. A. BODDIE and R. C. CURTIS; *J. A. I. E. E.*, 1929, p. 37.

Type D1. Single Channel Short Haul Carrier Telephone System, J. S. SANBORN ; *El. Com.*, Oct. 1930.
Experience With Carrier Current Communication, P. SPORN and R. H. WOLFORD ; *J. A. I. E. E.*, 1930.
The London-Paris-Madrid Telephone Service, L. G. FREETH ; *El. Com.*, Jan. 1930.
Carrier Systems in Spain, O. G. BAGWELL et J. R. GOPEGNI ; *El. Com.*, July 1930.
Carrier-current communication, P. SPORN and R. H. WOLDFORD ; *J. A. I. E. E.*, Feb. 1930.
Carrier current telephony, A. C. TIMMIS ; *I. P. O. E. E.*, paper No. 131.
Economic Factors in the design of single-core submarine cables for carrier telephony, J. R. VEZEY ; *El. Com.*, April 1931.
Carrier Current Systems form Important Part of World Communication Network, J. S. JAMMER ; *El. Com.*, Oct. 1932.
Transformer Coupling Circuits for High Frequency Amplifiers, A. J. CHRISTOPHER ; *B. S. T. J.*, Oct. 1932.
A Simplified Carrier Telephone System for Open Lines, R. J. HALSEY ; *P. O. E. E. J.*, July 1933.
Reconditioning telegraph circuits for audio and carrier working, E. J. WOODS ; *P. O. E. E. J.*, vol. 27, 1934.
Systems for Wide-Band Transmission Over Coaxial Lines, L. ESPENSCHIED and M. E. STRIEBY ; *B. S. T. J.*, Oct. 1934.
Recent advances in carrier telephony, R. J. HALSEY ; *P. O. E. E. J.*, vol. 27, 1935.
Wide Band Transmission Over Balanced Circuits, A. B. CLARK ; *B. S. T. J.*, Jan. 1935 ; *El. Eng.*, Jan. 1935.
Vacuum Tubes as High-Frequency Oscillators, M. J. KELLY und A. L. SAMUEL ; *El. Eng.*, Nov. 1934 ; *B. S. T. J.*, Jan. 1935.
Wide Band Transmission in Sheathed Conductors, O. B. BLACKWELL ; *B. T. Q.*, July 1935.
Hyper-Frequency Wave Guides—General Considerations and Experimental Results, G. C. SOUTHWORTH ; *B. S. T. J.*, April 1936.
Hyper-Frequency Wave Guides—Mathematical Theory, John R. CARSON, Sallie P. MEAD and S. A. SCHELKUNOFF; *B. S. T. J.*, April 1936.

(b) 3. General Rules concerning Transmission Systems for Radio Broadcasting.

Telephone Circuits for programme Transmission, F. A. COWAN ; *J. A. I. E. E.*, July 1929.
Radio broadcasting transmitter and related transmission phenomena, Edw. L. NELSON ; *Pr. I. R. E.*, Nov. 1929.
Wire Lines System for Broadcasting, A. B. CLARK ; *Pr. I. R. E.*, 1929, p. 1998.
Long Distance cable circuit for programme transmission, A. B. CLARK and C. W. GREEN ; *B. S. T. J.*, 1930, p. 567.
A Development in South African Broadcasting, C. McQUILLAN ; *El. Com.*, July 1930.
Underground circuits for the transmission of broadcast programmes, TIMMIS and BEER ; *P. O. E. E. J.*, Jan. 1931.
Principles of Audio Frequency Wire Broadcasting, P. P. ECKERSLEY ; *J. I. E. E.*, Sept. 1934.

(b) 4. General Rules concerning Transmission Systems for Television.

Some photographic problems in the transmission of pictures by electricity, IVES ; *B. repr.*, B. 190.
Transmission of pictures over telephone lines, IVES, HORTON, PARKER and CLARK ; *B. S. T. J.*, April 1925.
The wireless transmission of pictures, *Eng.*, 30 April, 1926.
Symposium on television from the Bell Telephone Laboratories ; *B. S. T. J.*, 1927, p. 551.
Radio Transmission System for Television, E. L. NELSON ; *B. S. T. J.*, 1927, p. 663.
Picture reception, *W. W.* and *R. R.*, 23 May, 1928.
Photo Telegraphy, Thorne BAKER ; *El. Rev.*, 17 Aug. 1928.
Picture Telegraphy, RITTER ; *P. O. E. E. J.*, Oct. 1928.
The Fultograph, HAYNES ; *W. W.* and *R. R.*, 24 Oct. 1928.
Electrical Engineering of Sound picture Systems, K. F. MORGAN and E. T. SHEA ; *J. A. I. E. E.*, 1929.
Phototelegraphy, RITTER ; *P. O. E. E. J.*, April 1930.
A system of Electrical Transmission of Pictures, NIWA ; *El. Com.*, April, 1930.
Image Transmission System for two-way television, H. E. IVES, F. GRAY, M. W. BALDWIN ; *B. S. T. J.*, July 1930.
Synchronisation System for two-way television, H. M. STOLLER, *B. S. T. J.*, July 1930.
Sound Transmission System for two-way television, D. G. BLATTNER and L. G. BOSTWICK ; *B. S. T. J.*, July 1930.
Two-way television system, H. E. IVES, F. GRAY and M. W. BALDWIN ; *B. S. T. J.*, July 1930.
Picture Telegraphy, G. E. CAW ; *P. O. E. E. J.*, July 1930.
Public Service of Phototelegraphy in Japan, SANNOSUKE INADA ; *El. Com.*, July 1931.
The Principles of the Light Valve, T. E. SHEA, W. HERRIOTT and W. R. GOEHNER ; *J. S. M. P. E.*, June 1932.
A Synchronising System for Electrical Transmission of Pictures, YASUJIRO NIWA ; *El. Com.*, Oct. 1932.

A Velocity-Modulation Television System, L. H. BEDFORD and O. S. PUCKLE; *J. I. E. E.*, July 1934.

A Theory of Scanning and Its Relation to the Characteristics of the Transmitted Signal in Telephotography and Television, Pierre MERTZ and Frank GRAY; *B. S. T. J.*, July 1934.

(c) 1. Apparatus: Subscribers' Sets.

Resonant Vibrations of Telephone Receiver Diaphragms, J. T. MACGREGOR-MORRIS and E. MALLETT; *J. I. E. E.* No. 61, Oct. 1923.

Some Acoustic Experiments with Telephone Receivers, E. MALLETT and G. F. DUTTON; *J. I. E. E.*, 1925, p. 502.

Phase Distortion in Telephone Apparatus, C. E. LANE; *B. S. T. J.*, 1930, p. 493.

Progress in Subscriber's Transmission Apparatus, L. C. POCOCK; *El. Com.*, April 1930.

The trend in design of telephone transmitters and receivers, W. H. MARTIN and W. F. DAVIDSON; *B. S. T. J.*, Oct. 1930.

The Development of the Microphone, H. A. FREDERICK; *B. T. Q.*, July 1931.

Moving coil telephone receivers and microphones, E. C. WENTE and A. L. THURAS; *B. S. T. J.*, Oct. 1931.

Development of a Handset for Telephone Stations, W. C. JONES and A. H. INGLIS; *B. S. T. J.*, April 1932.

The Manufacture of Rubber Covered wires for Telephone Installations, S. E. BRILLHART; *Mech. Eng.*, June 1932.

The Influence of Side Tones upon the Intelligibility of Telephone Communication, L. C. POCOCK; *El. Com.*, Jan. 1933.

A Compact A. C. Operated Speech Input Equipment, W. L. BLACK; *Pr. I. R. E.*, Oct. 1933.

The Carbon Microphone, F. S. GOUCHER; *J. Fr. I.*, April 1934, and *B. S. T. J.*, April 1934.

Characteristics of Telephone Receivers, W. WEST and D. MCMILLAN; *J. I. E. E.*, Sept. 1934.

Transmission test set for subscriber's apparatus, local lines and exchange apparatus, J. BARNES and R. E. SWIFT; *P. O. E. E. J.*, vol. 27, 1934.

Some Performance characteristics of the subscriber's transmitter, D. MCMILLAN; *P. O. E. E. J.*, vol. 28, 1935.

An Analysis of the Neophone Transmitter, G. W. SUTTON; *Siemens Magazine*, March 1935.

High quality carbon granule Transmitter for large outputs, G. W. SUTTON; *Siemens Magazine*, Feb. 1936.

A new subscriber's loud speaking telephone, L. E. RYALL; *P. O. E. E. J.*, vol. 29, 1936.

Spontaneous Resistance Fluctuations in Carbon Microphones and Other Granular Resistances, C. J. CHRISTENSEN and G. L. PEARSON; *B. S. T. J.*, April 1936.

The Neophone Differential Transmitter (Type 500), G. W. SUTTON; *Siemens Magazine*, Aug. 1936.

(c) 2. Apparatus: Local Telephone Exchanges.

Power plants for telephone offices, R. L. YOUNG; *B. S. T. J.*, 1927, p. 702.

Dial Telephone System serving small Communities of Southern California, F. O. WHEELOCK; *J. A. I. E. E.*, 1929, p. 800.

Country Satellite Exchanges, H. O. ELLIS and B. WINCH; *P. O. E. E. J.*, July 1933.

(c) 3. Apparatus: Toll Exchanges.

Tandem System for short haul toll calls, E. C. WHEELOCK and E. JACOBSEN; *J. A. I. E. E.*, 1928, p. 20.

Telephone repeaters (cord-circuits) at New Delhi, *P. O. E. E. J.*, Jan. 1929.

The Chicago Long Distance Toll Board, E. O. NEUBAUER and G. A. RUTGERS; *J. A. I. E. E.*, 1930, p. 11.

Recent Developments in Toll Telephone Service, W. H. HARRISON; *J. A. I. E. E.*, 1930, p. 195.

Voice Frequency Dialling—Field Trial Demonstration in Italy of four frequency Toll Signalling System; *El. Com.*, April 1930.

The Four Frequency Signalling System, T. A. SKILLMANN; *El. Com.*, July 1930.

Toll Plant Engineering, BRUCE H. MCCURDY; *El. Com.*, Jan. 1933.

Voice Frequency Signalling for Trunk Circuits, T. H. FLOWERS; *P. O. E. E. J.*, Jan. 1934.

Automatic Long Distance Switching-Impulse Transmission, S. VAN MIERLO and T. S. SKILLMAN; *El. Com.*, Jan. 1934.

Automatic Long Distance Switching-Rotary System, J. KRUITHOF et M. DEN HERTOG; *El. Com.*, Jan. 1934.

Automatic Long Distance Switching and National Dialling-Basle Switzerland, E. FREY; *El. Com.*, April 1934.

The British Post Office International Exchange, S. BIRCH and C. H. HARTWELL; *P. O. E. E. J.*, July 1934.

The London Trunk Centre, S. BIRCH; *P. O. E. E. J.*, Oct. 1934.

Signalling on trunk circuits. Introduction of two frequency working: Part I: H. S. SMITH, Part II: T. H. FLOWERS and B. M. HADFIELD; *P. O. E. E. J.*, vol. 29, 1936.

Tandem Operation in the Bell System, F. M. BRONSON, *B. S. T. J.*, July 1936.

Dial Switching of Connecticut Toll Calls, W. F. ROBB, A. M. MILLARD and G. M. MCPHEE; *El. Eng.*, July 1936.

(c) 4. Apparatus: Repeater Stations.

Four-wire Telephonic Repeater Systems, C. ROBINSON and R. M. CHAMNEY; *I. P. O. E. E.*, paper No. 83.

Telephone Repeaters, A. B. HART; *I. P. O. E. E.*, paper No. 75.

Recent Research Work on Telephone Repeaters, C. ROBINSON and R. M. CHAMNEY; *I. P. O. E. E.*, paper No. 99.

A modern Telephone Repeater Station, A. B. HART; *P. O. E. E. J.*, 1925, vol. XVIII, Part 3.

Aldeburgh Telephone Repeater Station, R. J. NUNN; *P. O. E. E. J.*, 1926, vol. XVIII, Part 4.

The Performance of Amplifiers, H. A. THOMAS; *J. I. E. E.*, 1926, p. 12.

Low-Frequency inter-valve transformers, P. W. WILLIAMS; *J. I. E. E.*, 1926, p. 158.

The Life-Testing of small Thermionic Valves, M. THOMPSON, R. H. DUDDERIDGE and L. G. A. SIMS; *J. I. E. E.*, 1926, p. 187.

Phase Relations in unbalanced Two-way Telephone Repeaters, L. T. HINTON, A. R. A. RENDALL and C. E. WHITE; *El. Com.*, July 1929.

A generalised Analysis of the Triode Valve Equivalent Network, F. M. COLEBROOK; *J. I. E. E.*, 1929.

The Development of the Oxide-Coated Filament, B. HODGSON, L. S. HARLEY and B. S PRATT; *J. I. E. E.*, 1929.

Negative Impedance and the Twin 21-Type Repeater, George CRISSON; *B. S. T. J.*, July 1931.

Precision Methods used in Constructing Electric Wave Filters, G. R. HARRIS; *B. S. T. J.*, April 1932.

Vacuum Tube and Photoelectric Tube Developments, M. J. KELLY; *J. S. M. P. E.*, June 1932.

Use of Telephone Repeaters with Train Dispatching and Message Circuits, H. A. AFFEL; *B. repr.* 723, June 1932.

Output Disturbances of Indirectly Heated Cathode Triodes, J. O. McNALLY; *Pr. I. R. E.*, Aug. 1932.

The New Quarter Ampere Repeater Tube and Its Applications, W. E. BENHAM, J. S. LYALL and A. R. A. RENDALL; *El Com.*, Oct. 1932.

The Toll Repeater, A. C. TIMMIS; *P. O. E. E. J.*, April 1933.

Electron Conduction in Thermionic Valves, W. E. BENHAM; *El. Com.*, April 1933.

Volume Efficiency of Repeatered Telephone Circuits, L. J. ABRAHAM; *B. S. T. J.*, Oct. 1933.

Stabilised Feed-Back Amplifiers, H. S. BLACK; *El. Eng.*, Jan. 1934 and *B. S. T. J.*, Jan. 1934.

Recent Repeater Station Installations, F. E. A. MANNING; *I. P. O. E. E.*, Paper No. 151.

Some Improvements in Quartz Crystal Circuit Elements, F. R. LACK, G. W. WILLARD and I. E. FAIR; *B. S. T. J.*, July 1934.

Phase Angle of Vacuum Tube Transconductance, F. B. LLEWELLYN; Pr. I. R. E., Aug. 1934.

Electrical wave-Filters Employing Quartz crystals as Elements, W. P. MASON; *B. S. T. J.*, July 1934.

Fluctuation Noise in Vacuum Tubes, G. L. PEARSON; *B. S. T. J.*, Oct. 1934.

The Measurement and Reduction of Microphonic Noise in Vacuum Tubes, D. B. PENICK; *B. S. T. J.*, Oct. 1934.

A few recent developments in telephone apparatus, L. E. RYALL; *P. O. E. E. J.*, vol. 27, 1934.

The valveless differential echo-suppressor, L. E. RYALL; *P. O. E. E. J.*, vol. 28, 1935.

Theory of Multi-Electrode Vacuum Tubes, H. A. PIDGEON; *El. Eng.*, Nov. 1934; *B. S. T. J.*, Jan. 1935.

Limits to Amplification, J. B. JOHNSON and F. B. LLEWELLYN; *El. Eng.*, Nov. 1934; *B. S. T. J.*, Jan. 1935.

(d) 1. Lines: Open Wire.

Telephone line insulators, L. T. WILSON; *B. S. T. J.*, Oct. 1930.

Motion of telephone wires in the wind, QUARLES; *B. repr.* B. 495.

The Transmission Characteristics of Open wire Telephone Lines, E. I. GREEN; *J. A. I. E. E.*, 1930.

New Standard Specifications for Wood Poles, R. L. JONES; *B. S. T. J.*, July 1931.

The Deoxidation of Copper with Various Metals, E. E. SCHUMACHER and W. C. ELLIS; *B. repr.* 707, 1932.

Joint Use of Poles with 6 900 Volt Lines, W. R. BULLARD and D. H. KEYES, *El. Eng.*, Dec. 1933.

Open Wire Crosstalk, A. G. CHAPMAN; *B. S. T. J.*, Jan. and April 1934.

Propagation of High Frequency Currents in Ground Return Circuits, W. H. WISE; *Pr. I. R. E.*, April 1934.

Wide-Band Open-Wire Programme System, H. S. HAMILTON; *El. Eng.*, April 1934, and *B. S. T. J.*, July 1934.

(d) 2. Lines: Cable.

Irregularities in continuously loaded cables, ROSEN; *J. I. E. E.*, vol. 65, No. 371.

New Anglo-Dutch Telephone Cable; *Elec.*, No. 93 (5 Sept., 1924) et *El. Rev.*, No. 95 (12 Sept., 1924).

Irregularities in Loaded Telephone Circuits, George CRISSON; *B. S. T. J.*, Oct. 1925.

The London-Glasgow Trunk Telephone Cable and its Repeater Stations, A. B. HART; *P. O. E. E. J.*, vol. XIX, Part 2 (1926).

London-Berlin Telephone Circuit; *P. O. E. E. J.*, vol. XIX, Part 2 (1926).

Science in the cable industry, DUNSHEATH; *El. Rev.*, 26 March, 1926.

The Anglo-Dutch No. 3 continuously Loaded Submarine Cable, A. B. MORICE ; *P. O. E. E. J.*, vol. XIX, Part 3 (1926).

Submarine insulation with special reference to the use of rubber, WILLIAMS and KEMP ; *J. F. I.*, Jan. 1927.

Some aspects of the electric capacity of telephone cables, MORRIS ; *P. O. E. E. J.*, April 1927.

The Anglo-French cable (1926) ; *P. O. E. E. J.*, July, 1927.

Quad telephone cables, MORRIS ; *Elec.*, 29 July 1927.

Air-space, paper-core, telephone cables of the twin, multiple twin and quad types, MORRIS ; *P. O. E. E. J.*, Oct. 1927.

Fatigue Studies of telephone cable sheath alloys, J. R. TOWNSHEND ; Testing Materials (Part 2), 1927, p. 153.

Transformation operators for use in cable balancing, MORRIS ; *P. O. E. E. J.*, Jan. 1928.

Loading coil cores and their magnetic stability, SHIDA ; *El. Com.*, Jan. 1928.

Fatigue Studies of Telephone Cables, J. R. TOWNSHEND ; *B. repr.* 285, 1928. Part 1.

Developments in the manufacture of paper-core telephone cables, HART ; *B. S. T. J.*, April 1928.

Telephone cable development, MERCER ; *W. P.*, March 1928.

Compressed powdered permalloy, SHACKLETON and BARBER ; *J. A. I. E. E.*, June 1928.

Recent developments in submarine cable design, HUGHES ; *J. I. E. E.*, No. 373, 1928.

Recent developments in the process of manufacturing lead covered telephone cables, C. D. HART ; *B. S. T. J.*, 1928, p. 321.

Telephonic line disturbance and cable balancing, ENGELHARDT ; *El. Rev.*, 21 Dec., 1928.

Cables (paper-core, twin, local, 1 800 pairs), RHODES ; *B. T. Q.*, Jan. 1929.

The Continuous Loaded Submarine Telegraph Cable, A. E. FOSTER, P. G. LEDGER and A. ROSEN ; *J. I. E. E.*, 1929.

Losses in armoured single conductor lead-covered A.C. cables, O. R. SCHURIG, H. P. KUERNI, F. H. BULLER ; *J. A. I. E. E.*, 1929, p. 206.

A New Contribution to the Rational Design of Telephone Cables, D. P. DALZELL ; *El. Com.*, Jan. 1930.

Czecho-Slovakian Cable System, F. J. STRINGER, W. F. MARRIAGE and E. L. E. PAWLEY ; *El. Com.*, Jan. 1930.

Fatigue Studies of Telephone Cables, J. R. TOWNSHEND and C. H. GREENALL ; *B. repr.* 69, 1930, II.

Some Recent Developments in Long Distance cables in the United States of America, A. B. CLARK ; *B. S. T. J.*, 1930, p. 487.

The Submarine link in international telephony, ROBINSON ; *I. P. O. E. E.*, paper No. 117.

Paragutta, a new insulating Material for Submarine Cables, A. R. KEMP ; *B. S. T. J.*, Jan. 1931.

Developments in the Manufacture of Telephone Cable, John R. SHEA ; *B. S. T. J.*, July 1931.

Long Telephone Lines in Canada, J. L. CLARKE ; *B. repr.*, B. 512.

Anglo-Belgian (1930) Submarine Telephone Cable, M. E. TUFNAIL and J. F. DOUST ; *P. O. E. E. J.*, Jan. 1931.

Telephone Cables, J. COLLARD ; *Elec.*, 27 Feb., 1931.

Telephone Cables, N. A. ALLEN ; *Elec.*, 6 and 13 March, 1931.

Anglo-French (1930) Submarine Telephone Cable, F. E. A. MANNING ; *P. O. E. E. J.*, April 1931.

Manufacture of lead-covered paper insulated telephone cable, J. R. SHEA ; *Mech. Eng.*, April 1931.

Trunk line aerial cable construction, G. W. CRADDUCK and W. H. BRENT ; *P. O. E. E. J.*, Oct. 1931.

A Continuously Loaded Cable for Use at High Frequencies, F. E. NANCARROW and H. STANESBY ; *P. O. E. E. J.*, Jan. 1932.

Modern Loading Equipment, J. B. KAYE ; *El. Com.*, Jan. and April 1932.

A New Key-West Havana Carrier Telephone Cable, H. A. AFFEL, W. S. GORTON and R. W. CHESNUT ; *B. S. T. J.*, April 1932.

Recent Developments in the Design of Loading Equipment for Junction Cables, A. O. GIBBON and W. H. BRENT ; *P. O. E. E. J.*, July 1932.

Capacity Unbalance in Telephone Cables and Its Effect on Noise due to External Induction, J. COLLARD ; *El. Com.*, Oct. 1932.

Long Distance Telephone Circuits in Cable, A. B. CLARK and H. S. OSBORNE ; *B. S. T. J.*, Oct. 1932.

Pulp Insulation for Telephone Cables, H. G. WALKER and L. S. FORD ; *B. S. T. J.*, Jan. 1933.

Carrier in Cable, A. B. CLARK et B. W. KENDALL ; *B. S. T. J.*, July 1933 and *El. Eng.*, July 1933.

Electrical Tests on the Anglo-Belgian (1932) Submarine Telephone Cable, E. M. RICHARDS ; *P. O. E. E. J.*, Oct. 1933.

Continuous Suspension of Aerial Cables, W. H. BRENT ; *P. O. E. E. J.*, Oct. 1933.

The New Italy-Sardinia Telephone Circuit, A. G. PESSION ; *El. Com.*, Oct. 1933.

The Variation of Overall Attenuation with Current Strength in a Telephone Circuit Loaded with Coils having Non-Linear Characteristics, K. E. LATIMER ; *El. Com.*, Oct. 1933.

Telephone Communications with the Channel Islands, A. C. TIMMIS ; *P. O. E. E. J.*, vol. 25, 1933.

Some Notes on the Design and Manufacture of Telephone Cables, F. H. BUCKLAND and R. H. FRANKLIN ; *I. P. O. E. E.*, paper No. 144.

The Anglo-French (1933) Submarine Telephone Cable, E. M. RICHARDS ; *P. O. E. E. J.*, Jan. 1934.

The Reduction of Impedance Irregularities in Submarine Cable Circuits by Allocation, C. TONINI, R. L. HUGHES and K. E. LATIMER; *El. Com.*, Jan. 1934.

Iron Shielding for Telephone Cables, H. R. MOORE; *El. Eng.*, Feb. 1934.

The Determination of Dielectric Properties at very High Frequencies, J. G. CHEFFEE; *Pr. I. R. E.*, Aug. 1934.

Cable Crosstalk—Effect of Non-Uniform Current Distribution in the Wires, R. N. HUNTER and R. P. BOOTH; *B. S. T. J.*, Jan. 1935.

Circulating Currents and Singing on Two-Wire Cable Circuits, L. G. ABRAHAM; *B. S. T. J.*, Oct. 1935.

(e) Maintenance of Lines and Apparatus.

Location of opens in toll telephone cables, P. G. EDWARDS and H. W. HERRINGTON; *B. S. T. J.*, 1927, p. 27.

Methods of Locating Crosstalk Faults on Loaded Cables, K. E. LATIMER; *El. Com.*, July 1929.

Transmission Maintenance of Telephone Systems, P. E. ERIKSON and R. A. MACK; *J. I. E. E.*, No. 62, pp. 653, 687 (Aug. 1924).

An Electron Tube Telemetering System, A. S. FITZGERALD; *J. A. I. E. E.*, 1930.

A Cathode Ray Oscillograph with Norinder Relay, O. ACKERMANN; *J. A. I. E. E.*, 1930.

Bridge Methods for Locating Resistance Faults on Cable Wires, T. C. HENNEBERGER, P. G. EDWARDS; *B. S. T. J.*, July 1931.

Telephone cable circuit interference, A. MORRIS; *I. P. O. E. E.*, paper No. 126.

A. C. methods of fault localisation in telephone cables, W. T. PALMER and M. E. TUFNAIL; *P. O. E. E. J.*, April 1930

Method of testing for distortion in audio frequency amplifiers, H. J. REICH; *Pr. I. R. E.*, March 1931.

(f) Simultaneous or Co-existing Telegraphy and Telephony.

Voice Frequency Multi-Channel Telegraph System, OWEN and MARTIN; *P. O. E. E. J.*, Jan. 1929.

Telephony and Telegraphy, W. CRUIKSHANK; *J. I. E. E.*, 1929.

Voice Frequency Telegraphs, W. CRUIKSHANK; *J. I. E. E.*, 1929.

Composited telegraph and telephone working, OWEN and MARTIN; *P. O. E. E. J.*, July 1929.

Voice-Frequency Telegraphs, CRUICKSHANK; *I. P. O. E. E.*, paper No. 113.

Developments in Machine Telegraph Systems and methods of Operation, H. H. HARRISON; *J. I. E. E.*, 1930.

Submarine Telegraphy, L. S. GOGGESHALL; *J. A. I. E. E.*, 1930.

Composited telegraph and telephone working, J. M. OWEN and J. A. S. MARTIN; *I. P. O. E. E.*, paper No. 130.

Telegraph Instrument rooms, Adoption of news methods, R. P. SMITH and F. T. CATTELL; *P. O. E. E. J.*, Jan. 1931.

Application of the thermostat to telegraph circuits, N. F. FROME; *P. O. E. E. J.*, Jan. 1931.

Private wire Telegraph Service, R. E. PIERCE; *El. Eng.*, Jan. 1931.

Interference in ocean cable telegraphy, J. W. MILNER; *El. Eng.*, April 1931.

All-mains Teleprinter duplex set, A. ARNOLD and A. E. DENMAN; *P. O. E. E. J.*, July 1931.

A System for Simultaneous Telephony and Telegraphy over Long Distance Small-Gauge Cables, L. A. BRAEM; *El. Com.*, Oct. 1931.

An all mains, voice frequency single channel high speed duplex telegraph system, J. M. OWEN; *P. O. E. E. J.*, vol. 25, 1932.

A voice frequency multi-channel telegraph system, J. M. OWEN and J. A. S. MARTIN; *P. O. E. E. J.*, vol. 25, 1932.

Telex, R. G. DE WARDT; *P. O. E. E. J.*, vol. 25, 1932.

New Voice Frequency Telegraph System, J. A. H. LLOYD, W. N. ROSEWAY, V. J. TERRY and A. W. MONTGOMERY; *El. Com.*, April 1932.

Teleprinter Private Wires on By-Product Circuits, R. G. DE WARDT; *P. O. E. E. J.*, July 1933.

The new inland telegraph service, C. J. MERCER; *P. O. E. E. J.*, vol. 26, 1933.

Sub-Audio Telegraph Working on a Continuously Loaded Submarine Telephone Cable, J. G. STRAW and A. ARNOLD; *P. O. E. E. J.*, April 1934.

A Four-Channel Duplex Voice frequency Telegraph System, MITCHELL; *P. O. E. E. J.*, vol. 27, 1935.

A new high speed multi-channel carrier telegraph system, G. T. EVANS and L. T. ARMAN; *P. O. E. E. J.*, vol. 27, 1935.

(g) Co-ordination of Radiotelephony and Telephony.

Power amplifiers in transatlantic telephony, OSWALD and SCHELLENG; *B. repr.*, B. 130–1.

Faithful Reproduction in Radio-Telephony, L. C. POCOCK; *J. I. E. E.*, 1924, p. 791.

Production of single side-band for transatlantic radio-telephony, HEISING; *B. repr.*, B. 131 and *Pr. I. R. E.*, June 1925.

Transatlantic radio telephone transmission, ESPENSCHIED, ANDERSON and BAILLEY; *B. S. T. J.*, vol. IV, No. 3, July 1925.

The Rugby Radio Station of the British Post Office, E. H. SHAUGHNESSY ; *J. I. E. E.*, 1926, p. 113.

Transmission features of transcontinental telephony, H. H. NANCE and O. B. JACOBS ; *J. A. I. E. E.*, 1926, p. 1061.

The New York-London telephone circuit, S. B. WRIGHT and H. C. SILENT ; *B. S. T. J.*, 1927, p. 376.

Transatlantic radio-telephony, BOWN ; *B. S. T. J.*, April 1927.

The London-New York telephone circuit, HANSFORD ; *P. O. E. E. J.*, April 1927.

Transatlantic Telephony : the P. O. differential voice-operated anti-singing equipment, BEER and EVANS ; *P. O. E. E. J.*, April 1927.

Transatlantic Telephony : the technical problem, O. B. BLACKWELL ; *J. A. I. E. E.*, 1928 (May) and *B. S. T. J.*, 1928, p. 187.

Transatlantic Telephony : service and operating features, K. W. WATERSON ; *J. A. I. E. E.*, April 1928.

Transatlantic Telephony : the Cupar receiving station, *Eng.*, 24th Aug. 1928.

Transatlantic Telephony, JEWETT ; *B. repr.*, E. 166.

The receiving system for long wave transatlantic Radio telephony, Austin BAILEY, S. W. DEAN and W. WINTRINGHAM ; *Pr. I. R. E.*, Dec. 1928, and *B. S. T. J.*, 1929, p. 309.

Some principles of Broadcast Frequency Allocation, L. E. WHITTEMORE ; *Pr. I. R. E.*, 1929, p. 1343.

Radio Interference from Line Insulators, Ellis VAN ATTA and E. L. WHITE ; *J. A. I. E. E.*, 1929.

The Design of Transmitting Aerials for Broadcasting Stations, P. P. ECKERSLEY, T. L. ECKERSLEY and H. L. KIRKE ; *J. I. E. E.*, 1929.

Investigation of Short Waves, T. L. ECKERSLEY ; *J. I. E. E.*, 1929.

A portable radio intensity measuring apparatus for high frequencies, J. HOLLINGWORTH R. and NAISMITH ; *J. I. E. E.*, 1929.

Radio Telephony and Radio Telegraphy, E. B. MOULLIN, *J. I. E. E.*, 1929.

The Operation of Several Broadcasting Stations on the Same Wavelength, P. P. ECKERSLEY and A. B. HOWE ; *J. I. E. E.*, 1929.

The Action of a Reflecting Antenna, L. S. PALINA, L. LEY and K. HONEYBALL ; *J. I. E. E.*, 1929.

The Attenuation of Wireless Waves over towns, R. H. BARFIELD and G. H. MUNRO ; *J. I. E. E.*, 1929.

Ship to Shore Terminal Equipment, A. S. ANGWIN ; *El. Com.*, July 1930.

Series of Special Articles on the Madrid-Buenos Aires Radio Link ; *El. Com.*, Feb. 1930.

The New York-Buenos Aires Radio Circuit, H. H. BUTTNER ; *El. Com.*, April 1930.

Transoceanic Telephone Service—Short Wave Transmission, Ralph BOWN ; *B. S. T. J.*, 1930, p. 258.

Transoceanic Telephone Service—Short Wave Equipment, A. A. OSWALD ; *B. S. T. J.*, 1930, p. 270.

Transoceanic Telephone Service—Short Wave Stations, F. A. COVAN ; *J. A. I. E. E.*, 1930, p. 638.

Radio Telephone Service to Ships at Sea, Wm. WILSON and Lloyd ESPENSCHIED ; *B. S. T. J.*, 1930, p. 407.

Transoceanic Telephone Service, T. G. MILLER ; *J. A. I. E. E.*, 1930.

The Valve Maintained Quartz Oscillator, J. E. P. VIGOUREUX ; *J. I. E. E.*, 1930.

Frequency Stabilization of Valve Oscillators, E. MALLETT ; *J. I. E. E.*, 1930.

Radio Communication services of the British Post Office, A. G. LEE ; *Pr. I. R. E.*, Oct. 1930.

Long wave radio telephone-telegraph transmitters, D. B. MIRK and S. G. KNIGHT ; *Elect. Com.*, Jan. 1931.

Overseas radio extensions to wire telephone networks, L. ESPENSCHIED and W. WILSON : *B. S. T. J.*, April 1931.

Radio telephony terminal, W. H. SCARBOROUGH ; *P. O. E. E. J.*, April 1931.

Diversity Telephone receiving system of R. C. A. Communications Inc., H. O. PETERSON, H. H. BEVERAGE and J. B. MOORE ; *Pr. I. R. E.*, April 1931.

Telephony on 15 centimetres ; *W. W.*, 15th April 1931.

Notes on Radio Transmission, CLIFFORD N. ANDERSON ; *Pr. I. R. E.*, July 1931.

Developments in short wave directive antennas, E. BRUCE ; *Pr. I. R. E.*, Aug. 1931.

Radio transmission studies of the upper atmosphere, J. P. SCHAFER and W. M. GOODALL ; *Pr. I. R. E.*, Aug. 1931.

Theoretical and practical aspects of directional antennas, E. J. STERBA ; *Pr. I. R. E.*, July 1931.

The propagation of short radio waves over the North Atlantic, G. BURROWS ; *Pr. I. R. E.*, Sept. 1931.

Some developments in common frequency broadcasting, G. D. GILLET ; *B. S. T. J.*, Oct. 1931.

The grounded condenser antenna radiation formula, W. H. WISE ; *Pr. I. R. E.*, Oct. 1931.

Intercontinental radio telephone service from the United States, J. J. PILLIOD ; *B. repr.*, B. 604.

The Spread Side-Band System on Short Wave Telephone Links, L. T. HINTON ; *El. Com.*, Oct. 1931.

Operation of a Ship-Shore Radiotelephone System, C. N. ANDERSON and I. E. LATTIMER ; *Pr. I. R. E.*, March 1932.

Some Effects of Topography and Ground on Short-Wave Reception, R. K. POTTER and H. T. FRIIS ; *Pr. I. R. E.*, April 1932.

Wire Communication Aids to Air Transportation, H. H. NANCE ; *B. S. T. J.*, July 1932.

Transmission Lines for Short-Wave Radio Systems, E. J. STERBA and C. B. FELDMAN ; *Pr. I. R. E.*, July 1932, and *B. S. T. J.*, July 1932.

Two-Way Radio Telephone Circuits, S. B. WRIGHT and D. MITCHELL ; *Pr. I. R. E.*, July 1932, and *B. S. T. J.*, July 1932.

Standard Broadcasting Land Line Equipment, A. R. A. RENDALL and J. S. LYALL ; *El. Com.*, July 1932.

The Swiss Broadcast Network, A. MURI ; *El. Com.*, July 1932.

A Note on an Automatic Field Strength and Static Recorder, W. W. MUTCH ; *Pr. I. R. E.*, Dec. 1932.

North Atlantic Ship-Shore Radiotelephone Transmission, C. N. ANDERSON ; *Pr. I. R. E.*, Jan. 1933.

Short-Wave Transmission to South America, C. R. BURROWS and E. J. HOWARD ; *Pr. I. R. E.*, Jan. 1933.

Ultra-Short Wave Propagation, J. C. SCHELLENG, C. R. BURROWS and E. B. FERRELL ; *Pr. I. R. E.*, March 1933, and *B. S. T. J.*, April 1933.

The Design of Filters for Carrier Programme Circuits, F. RALPH ; *El. Com.*, April 1933.

Production and Utilisation of Micro-Rays, A. G. CLAVIER ; *El. Com.*, July 1933.

The Radio Patrol System of the City of New York, T. W. ROCHESTER and F. W. CUNNINGHAM ; *Pr. I. R. E.*, Sept. 1933.

Audio Frequency Atmospherics, E. T. BURTON and E. M. BOARDMAN ; *Pr. I. R. E.*, Oct. 1933, and *B. S. T. J.*, Oct. 1933.

The Single Side-Band System Applied to Short-Wave Telephone Links, A. H. REEVES ; *El. Com.*, Oct. 1933.

Privacy Systems for Radio Telephony, A. J. GILL ; *P. O. E. E. J.*, Oct. 1933.

The Anglo-French Micro-Ray Link between Lympne and St. Inglevert, A. G. CLAVIER and L. C. GALLANT ; *El. Com.*, Jan. 1934.

Line Filter for Programme System, A. W. CLEMENT ; *El. Eng.*, April 1934.

The Compandor—An Aid against Static in Radio Telephony, R. C. MATHES and S. B. WRIGHT ; *El. Eng.*, June 1934, and *B. S. T. J.*, July 1934.

A Single-Sideband Short-Wave System for Transatlantic Telephony, F. A. POLKINGHORN and N. F. SCHLAACK ; *Pr. I. R. E.*, July 1935 ; *B. S. T. J.*, July 1935.

An Unattended Ultra-Short-Wave Radio Telephone System, N. F. SCHLAACK and F. A. POLKINGHORN ; *B. S. T. J.*, July 1935 ; *Pr. I. R. E.*, Oct. 1935.

Ship-to-Shore Radio in Puget Sound Area, E. B. HANSEN ; *El. Eng.*, Aug. 1935.

The Hawaiian Radiotelephone System, W. I. HARRINGTON and C. W. HANSELL ; *El. Eng.*, Aug. 1935.

Transatlantic Long-Wave Radio Telephone Transmission and Related Phenomena from 1923 to 1933, Austin BAILEY and Howard M. THOMSON ; *B. S. T. J.*, Oct. 1935.

Marine Radio Telephone Service for Boston Harbour, F. A. GIFFORD and R. B. MEADER ; *Communication and Broadcast Engineering*, Oct. 1935.

Ships' Sets for Harbour Ship-to-Shore Service, H. N. WILLETS ; *B. S. T. J.*, Oct. 1935.

The Reliability of Short-Wave Radio Telephone Circuits. R. K. POTTER and A. C. PETERSON, Jr. ; *B. S. T. J.*, April 1936.

(h) Measurements : Methods and Apparatus.

A Method for the Measurement of the Transmission Efficiency of Telephone Apparatus at a Subscriber's Office, A. J. ALDRIDGE and HUDSON ; *P. O. E. E. J.*, 1924, volume 17, Part 2.

Comparison of Frequencies by Cathode-Ray Tube, D. W. DYE ; *Pr. Ph. S.*, No. 37, pages 158–168, April 1925.

High Frequency Measurements of Communication Lines, AFFEL and O'LEARY ; *B. repr.*, B. 317.

Frequency Characteristics of Telephone Systems and Audio Frequency Apparatus and their Measurement, B. S. COHEN, A. J. ALDRIDGE and W. WEST ; *J. I. E. E.*, 1926, page 206.

Testing of Telephonic Circuits and Apparatus with Alternating Currents, RITTER and MILTON ; *I. P. O. E. E.*, paper No. 110.

Frequency Measurements with the Cathode Ray Oscillograph, F. J. RASMUSSEN ; *J. A. I. E. E.*, 1927, page 3.

Apparatus Standards of Telephone Transmission and the Technique of Testing Microphones and Receivers, B. S. COHEN ; *El. Rev.*, Dec. 1927, and *J. I. E. E.*, No. 374, Feb. 1928.

Electrical Measurement of Communication Apparatus, W. J. SHACKLETON et J. G. FERGUSSON ; *B. S. T. J.*, 1928, page 70.

Measurement of Capacitance in Terms of Resistance and Frequency, J. G. FERGUSSON and B. W. BARTLETT ; *B. S. T. J.*, 1928, page 420.

Routine Transmission Testing of Subscribers' Instruments at the Exchange and at the Subscriber's Office, HUDSON ; *P. O. E. E. J.*, Jan. 1929.

Articulation Testing Methods, H. FLETCHER and J. C. STEINBERG ; *B. S. T. J.*, 1929, page 806.

Speech Power and Its Measurement, L. J. SIVIAN ; *B. S. T. J.*, 1929, page 646.

The Accurate Measurement of Articulation, J. COLLARD ; *P. O. E. E. J.*, April 1930.

Measurement of Sound and Its Application to Telephony, A. J. ALDRIDGE ; *I. P. O. E. E.*, paper No. 124.

Measurements of Long Telephone Lines by the "Open and Closed" Method, A. ROSEN ; *J. I. E. E.*, 1930.

Alternating Current Test on High Speed Telegraph Cable, E. W. SMITH ; *J. I. E. E.*, 1930.

High Frequency Resistance Measurements by the Use of a Variable Mutual Inductance, W. JACKSON ; *J. I. E. E.*, 1930.

Microphone Measurements and Microphone Arrangements, S. LEMOINE ; *El. Com.*, Oct. 1930.

Measurement of Reverberation Time, F. L. HOPPER ; *J. A. S. A.*, April 1931.

Telephone Instrument Efficiency Tester, A. HUDSON ; *P. O. E. E. J.*, April 1931.

A Direct Reading Audio-Frequency Phase Meter, W. R. MACLEAN and L. J. SIVIAN ; *J. A. S. A.*, April 1931.

Frequency Measurement in the British Post Office, F. E. NANCARROW ; *P. O. E. E. J.*, July 1931.

Indicating Meter for Measurement and Analysis of Noise, T. J. CASTNER, E. DIETZE, G. T. STANTON and R. S. TUCKER ; *B. repr.*, B. 563.

Transmission Testing of Subscriber's Apparatus, L. C. POCOCK ; *El. Com.*, Oct. 1931.

Lining Up Broadcasting Circuits, E. K. SANDEMAN ; *El. Com.*, Jan. 1932, page 131.

A Method of Measuring Acoustic Impedance, P. B. FLANDERS ; *B. S. T. J.*, July 1932, pages 402–410.

Some Acoustic and Telephone Measurements, H. R. HARBOTTLE ; *J. I. E. E.*, Oct. 1932.

Special Noise Testing Equipment, D. H. MACNEE ; *El. Com.*, Jan. 1933, page 128.

A Recording Transmission Measuring System for Telephone Circuit Testing, F. H. BEST ; *B. S. T. J.*, Jan. 1933, pages 22–34.

An Oscillograph for 10 000 Cycles, A. M. CURTIS ; *B. S. T. J.* Jan. 1933, pages 76–90.

Electrode Testing Methods Applied to Telephone Cables, W. T. PALMER and F. E. A. MANNING ; *P. O. E. E. J.*, April 1933.

Measurement of the Mutual Impedance of Circuits with Earth Return, J. COLLARD ; *El. Com.*, July 1933, page 24.

Telephone Cable Testing, W. T. PALMER and E. H. JOLLEY ; *I. P. O. E. E.*, paper No. 138, 1933.

Bridge Methods of measuring Impedances, J. F. FERGUSON ; *B. S. T. J.*, Oct. 1933.

A Transmission Test Set for Subscribers' Instruments, Local Lines and Exchange Apparatus, E. J. BARNES and R. E. SWIFT ; *P. O. E. E. J.*, Oct. 1934.

Acoustical Instruments, E. C. WENTE ; *J. A. S. A.*, July 1935 ; *B. S. T. J.*, July 1935.

Improved Types of Transmission Measuring Systems and Methods of Measurement, W. H. HARDEN ; *Proceedings, Association of American Railroads (Telegraph and Telephone Section)*, June 1935.

Measurement of Telephone Noise and Power Wave Shapes, J. M. BARSTOW, P. W. BLYE and H. E. KENT ; *El. Eng.*, Dec. 1935.

Tentative Standards for Sound Level Meters, R. G. MCCURDY ; *El. Eng.*, March 1936.

A Non-Directional Microphone, R. N. MARSHALL and F. F. ROMANOW ; *B. S. T. J.*, July 1936.

Articles on Standardization of Acoustical Measurements and Terminology, Vern O. KNUDSEN, Harvey FLETCHER and R. G. MCCURDY ; *Industrial Standardization and Commercial Standards Monthly*, April 1936.

III. PUBLICATIONS IN FRENCH.

(a) 1. General : Transmission Standards and Definitions.

Circuit de référence pour les mesures de transmission téléphonique, L. J. SIVIAN ; *A. P. T. T.*, juin 1925, p. 560.

Le Système fondamental de référence pour les mesures de transmission téléphonique, P. CHAVASSE ; *A. P. T. T.*, novembre 1928.

Note sur un système téléphonométrique étalon primaire utilisant un microphone à quartz, CHAVASSE et GOSSELIN ; *A. P. T. T.*, février 1930, p. 145.

Equivalent de transmission, J. B. POMEY ; *R. G. E.*, 29 mars 1930, p. 475.

Sur la terminologie utilisée en téléphonométrie, M. BIGORGNE ; *A. P. T. T.*, août 1930, p. 733.

Sur la définition et la mesure du crosstalk, J. CARVALLO ; *A. P. T. T.*, sept. 1925, p. 887.

Limites pratiques de l'équivalent de référence du système émetteur national et du système récepteur national dans une communication téléphonique internationale, R. BIGORGNE ; *A. P. T. T.*, mai 1932.

Les origines du décibel, J. B. POMEY ; *Revue de la S. I. F.*, mars 1933.

Ecouteur téléphonique électrostatique, LONGO ; *Onde Elect.*, mai 1933.

Relation entre l'équivalent et l'affaiblissement à 800 périodes par seconde d'une ligne téléphonique homogène ; R. BIGORGNE, P. MARZIN, J. MEYER ; *A. P. T. T.*, novembre 1933.

(a) 2. General : Recommendations of Principle.

Le quadripôle, J. B. POMEY ; *Journ. Télégr.*, janvier 1925, p. 3.

Effet de la variation de la distance entre bobines de charge d'un circuit, sur l'impédance caractéristique, COLLARD ; *B. Tech., T. T. suisses*, année 1925, n° 2.

Impédance caractéristique et affaiblissement kilométrique des câbles sous papier et plomb, COLLET et CHAVASSE ; *A. P. T. T.*, février 1926.

Sur la transmission d'énergie par les systèmes dits quadripôles passifs, RAVUT ; *R. G. E.*, 17, 24 avril 1926.

Le quadripôle, COLLET ; *A. P. T. T.*, novembre 1926, p. 439.

Sur une expression de l'énergie transmise par un quadripôle neutre, J. B. POMEY ; *R. G. E.*, 31 mars 1928.

Sur la distorsion téléphonique et sa mesure, DAVID ; *A. P. T. T.*, avril 1928.

Addition des affaiblissements effectifs, P. MOCQUARD ; *A. P. T. T.*, août 1928.

Sur les constantes du quadripôle passif, TELLINGEN ; *R. G. E.*, 11 août 1928.

Les ondes électro-motrices, AGUILLON ; *A. P. T. T.*, octobre 1928 et février 1929.

La notion d'admittance caractéristique, L. J. COLLET ; *A. P. T. T.*, novembre 1929, p. 980.

Sur le développement en série de l'impédance d'une ligne uniforme, J. B. POMEY ; *R. G. E.*, 1er février 1930, p. 163.

Quadripôles et filtres, par J. B. POMEY ; *R. G. E.*, 15 février 1930, p. 235.

Les multipôles et leurs divers circuits indépendants, J. B. POMEY ; *R. G. E.*, 28 février 1931, p. 335.

Recherche de la force électromotrice fictive d'un transmetteur microphonique, P. MASSAULT ; *Onde élec.*, juillet 1931, p. 303.

Contributions théoriques et pratiques à la technique des communications à longue distance. Exposé critique des principales méthodes d'étude de l'équation des télégraphistes et de ses conséquences, par P. LÉVY, de la Société d'études pour liaisons téléphoniques et télégraphiques à longue distance, Paris.

Etude du courant dans un circuit à résistance variable, J. B. POMEY ; *R. G. E.*, 20 février 1932.

Champ électromagnétique produit par un fil parcouru par un courant alternatif sinusoïdal au-dessus d'une couche conductrice, DUBOURDIEU ; *C. R. Académie des Sciences*, 7 mars 1932.

Etude du courant dans un circuit à inductance variable, J. B. POMEY ; *R. G. E.*, 9 avril 1932.

Le mécanisme de la production des oscillations, Ph. LE CORBEILLER ; *A. P. T. T.*, août 1932.

Sur les constantes électriques des réseaux à maille, C. RAVUT ; *R. G. E.*, 24 décembre 1932.

Impédances itératives, J. B. POMEY ; *R. G. E.*, 11 février 1933.

Théorie de la propagation de l'énergie électrique sur les lignes de transmission, A. LES BLAHA ; *R. G. E.*, 18 février 1933.

Jonction entre deux lignes d'impédances caractéristiques différentes, J. B. POMEY ; *R. G. E.*, 18 mars 1933.

Le mécanisme de la production des oscillations, LE CORBEILLER ; *Onde Elec.*, mars 1933.

Transformateur parfait, synapteur idéal et transducteur parfait. Comportements, affaiblissements et coléphasements des systèmes transmetteurs, P. C. VANDEWIÈLE ; *R. G. E.*, 15 avril 1933.

La propagation des ondes électromagnétiques, J. B. POMEY ; *R. G. E.*, 29 juillet 1933.

Les niveaux en électroacoustique, P. C. VANDEWIÈLE ; *R. G. E.*, 22 juillet 1933.

Equilibrage des dyssymétries de capacité dans les câbles toronnés en quartes, E. GAY ; *B. techn. T. T. suisses*, octobre 1933.

Sur quelques théorèmes généraux de transmission, P. C. VANDEWIÈLE ; *B. S. F. E.*, novembre 1933.

Constante de temps et sélectivité de circuits couplés par tubes électroniques, G. FAYARD ; *R. T. T.* et *T. S. F.*, février 1934.

Contributions à l'étude du récepteur téléphonique, M. MARINESCO ; *A. P. T. T.*, juillet 1934.

Recherches sur la construction de circuits pour courants de haute fréquence, H. JANNÈS et P. MARZIN ; *A. P. T. T.*, juillet 1934, p. 605.

Protection des lignes téléphoniques contre les courants industriels.—Etat de certaines questions après la dernière Assemblée du C.C.I.F. (Budapest, septembre 1934), G. L. OLLIER ; *A. P. T. T.*, décembre 1934, p. 1061.

Etude de la stabilité d'un réseau à réaction, d'après H. NYQUIST, Ph. LE CORBEILLER ; *A. P. T. T.*, novembre 1934, p. 1010.

Quelques expériences nouvelles relatives aux influences nuisibles causées par les courants forts aux usagers et au matériel des installations de télécommunication ; *A. P. T. T.*, novembre 1934, p. 1028.

Oscillations libres dans un câble téléphonique, Mario MARRO ; *R. G. E.*, 14 avril 1934, p. 491.

Expériences relatives à la téléphonie par courants pulsatoires, Mario MARRO ; *R. G. E.*, 15 septembre 1934, p. 367.

Ecran en fer pour câbles téléphoniques, H. R. MOORE ; *R. G. E.*, 18 août 1934, p. 251.

Les caractéristiques acoustiques d'un haut-parleur à cône, D. A. OLIVER ; *R. G. E.*, 14 juillet 1934, p. 60.

Sur la théorie des filtres électriques, VACLAR BUBENIK ; *R. G. E.*, 30 juin 1934, p. 875.

Etude du champ magnétique produit par un courant de basse fréquence circulant dans un conducteur en présence du sol, M. C. BOURGONIER ; *B. S. F. E.*, mars 1934, p. 261.

A propos des effets d'induction électromagnétiques entre les lignes de transmission d'énergie et les lignes de télécommunication, M. J. FALLOU ; *B. S. F. E.*, mars 1934, p. 229.

Sur la stabilité d'un réseau à réaction ; Marcel BAYARD ; *A. P. T. T.*, février 1935, p. 109.

Relation entre l'affaiblissement et le déphasage d'un système de transmission linéaire, R. LEROY ; *A. P. T. T.*, août 1935, p. 733.

Note sur le théorème d'addition des affaiblissements transductiques, M. BÉLUS ; *A. P. T. T.*, novembre 1935, p. 993.

Sur quelques dispositifs de stabilisation commandés par les courants vocaux, R. BIGORGNE et P. MARZIN ; *A. P. T. T.*, juin 1935, p. 573.

Dispositifs antiparasites pour circuit téléphonique, R. BIGORGNE et P. MARZIN ; *A. P. T. T.*, novembre 1935, p. 1016.

Méthode de calcul des réseaux d'impédance, V. BARANOV ; *R. G. E.*, 16 mars 1935, p. 339.

Relations entre les parties réelles et imaginaires des impédances et détermination des impédances en fonction de l'une des parties, M. BAYARD ; *R. G. E.*, 25 mai 1935, p. 659.

Influence d'un écran entourant un circuit téléphonique en ce qui concerne les caractéristiques de ce circuit et effet protecteur de l'écran contre les couplages, L. FARGEAS ; *R. G. E.*, 22 juin 1935, p. 787.

Les fluctuations de courant, J. B. POMEY ; *R. G. E.*, 3 août 1935, p. 163.

Sur la théorie des filtres de W. CAUER, R. JULIA ; *B. S. F. E.*, octobre 1935, p. 983.

La propagation des ondes électromagnétiques dans les circuits hétérogènes, S. TESZNER ; *R. G. E.*, 23 novembre 1935, p. 695.

Introduction aux applications du calcul symbolique de Heaviside aux problèmes de l'électrotechnique, André BLONDEL ; *R. G. E.*, 18 janvier 1936, p. 83 ; 25 janvier 1936, p. 133 ; 1er février 1936, p. 179 ; 8 février 1936, p. 219.

Le condensateur employé comme microphone, J. B. POMEY ; *R. G. E.*, 16 mai 1936, p. 720.

Etude graphique des circuits en pi, V. GENKIN ; *R. G. E.*, 13 juin 1936, p. 851.

Sur la réaction en basse fréquence dans les amplificateurs à lampes, M. MARINESCO, *Onde Elec.*, juillet 1936, p. 469.

(b) 1. General Rules concerning Transmission Systems for Ordinary Telephony.

Sur la propagation du courant en période variable, sur une ligne munie d'un récepteur, POINCARÉ ; *Ecl. Electr.*, année 1904, Vol. XL, pp. 121, 161, 201, 241.

Les lignes Krarup et la téléphonie à grande distance, DEVAUX-CHARBONNEL ; *B. S. I. E.*, février 1916.

La contribution des ingénieurs français à la téléphonie à grande distance par câbles souterrains ; Vaschy et Barbarat, DEVAUX-CHARBONNEL ; *R. G. E.*, 25 août 1917, p. 288.

Lignes artificielles, J. B. POMEY ; *R. G. E.*, 26 janvier 1918, p. 123.

Théorème de Pleijel, J. B. POMEY ; *R. G. E.*, 26 avril 1919, p. 622.

Propagation du courant sur une ligne téléphonique homogène. Régime variable avec appareil aux extrémités, J. B. POMEY ; *R. G. E.*, 2 août 1919, p. 131.

Introduction à la théorie des courants téléphoniques et de la radio-télégraphie, J. B. POMEY (Gauthier-Villars et Cie, Paris, 1920).

Propagation des courants sinusoïdaux sur les lignes quelconques, RAVUT ; *R. G. E.*, t. VIII, n° 19, 8 mai 1920.

Sur quelques propriétés générales des réseaux parcourus par des courants alternatifs en régime permanent, RAVUT ; *R. G. E.*, 8 mai, 20 et 27 octobre 1923, 8 mars 1924.

Note sur la théorie des lignes artificielles ; *A. P. T. T.*, avril 1925, p. 385.

La transmission téléphonique dans une grande cité moderne et dans sa banlieue envisagée au point de vue économique, L. AGUILLON et G. VALENSI ; *A. P. T. T.*, octobre 1925, p. 905, et novembre 1925, p. 1025.

Théorie des relais téléphoniques et télégraphiques, R. PARÉSY ; *R. G. E.*, 1er janvier 1927, p. 3, et 8 janvier 1927, p. 43.

L'adaptation du réseau français au service téléphonique universel, H. MILON ; *A. P. T. T.*, janvier 1928.

L'organisation du réseau téléphonique des Etats-Unis ; *R. T. T. et T. S. F.*, décembre 1930, p. 856.

Théorie élémentaire des circuits à deux fils, par R. BÉLUS et P. M. PRACHE ; *A. P. T. T.*, août 1931.

Le service téléphonique dans la banlieue de Paris, par M. UZENOT ; *A. P. T. T.*, septembre 1931.

Sur le calcul de l'affaiblissement effectif d'une liaison téléphonique complexe, R. BIGORGNE ; *A. P. T. T.*, août 1933.

Calcul de l'équivalent de référence d'une liaison téléphonique, R. BIGORGNE et P. MARZIN ; *A. P. T. T.*, décembre 1933.

Câbles de raccordement pour les installations électriques, G. OLLIER ; *A. P. T. T.*, février 1932.

Etude sur le réaménagement d'un réseau téléphonique aéro-souterrain dans une zone à moyenne densité d'abonnés, DAUVIN et DURANT ; *A. P. T. T.*, juillet 1933.

Notes sur des questions traitées à la Xe Assemblée plénière du C.C.I.F.—Transmission (Lignes), M. PARMENTIER ; *A. P. T. T.*, juillet 1935, p. 609.

Notes sur des questions traitées à la Xe Assemblée plénière du C.C.I.F.—Qualité de transmission et appareils d'abonnés, P. CHAVASSE ; *A. P. T. T.*, août 1935, p. 741.

Câble de contre-couplage, nouveau procédé d'équilibrage des dyssymétries des capacités partielles entre conducteurs d'une quarte de câble téléphonique, M. H. W. DROSTE ; *A. P. T. T.*, octobre 1935, p. 873.

Expériences effectuées sur un câble régional compensé par le procédé du câble de contre-couplage, K. SIEBER ; *A. P. T. T.*, octobre 1935, p. 882.

(b) 2. General Rules concerning Transmission Systems for Carrier Telephony.

Théorie des filtres électriques, LANGE ; *A. P. T. T.*, octobre 1923, p. 1256.

Etude sur les lignes en T et II dyssymétriques ; applications aux filtres de bandes, LE CORBEILLER et LANGE ; *Onde Elec.*, octobre 1923.

Essai sur la théorie des filtres électriques, DAVID ; *Onde Elec.*, janvier-février 1926.

Les filtres électriques, MICHAUD ; *Rad. Elect.*, 25 mai 1926, p. 192.

Filtres acoustiques, CANAC ; *Journ. Phys. et Rad.*, juin 1926, p. 161.

Sur une proposition fondamentale de la théorie des filtres électriques, J. B. POMEY ; *R. G. E.*, 21 février 1928.

Détermination de la condition d'entretien et de la période d'oscillation d'un oscillateur triode, ABÉLÈS ; *R. G. E.*, 21 avril 1928.

Etude sur un filtre, G. FAYARD ; *Bulletin de la S. F. R.*, juin 1929.

Transmission simultanée de deux communications téléphoniques secrètes, FAYARD ; *B. S. F. E.*, octobre 1929, p. 1146.

Sur les liaisons téléphoniques en haute fréquence le long des lignes d'énergie électrique, C. GUTTON ; *A. P. T. T.*, novembre 1929, p. 969.

Une communication bilatérale réalisée avec un seul circuit ; *R. T. T.* et *T. S. F.*, décembre 1930, p. 870.

Le développement des systèmes téléphoniques à courants porteurs en France, R. LOUBATIÉ ; *A. P. T. T.*, avril 1931, p. 259.

Téléphonie par courants porteurs sur lignes à haute tension, M. SAGLIO ; *Onde Elec.*, mai 1931, p. 189.

Téléphonie à deux bandes de fréquence, *A. P. T. T.*, septembre 1932.

La sélection interurbaine, *B. techn. T. T. Suisses*, février 1933.

Les transmissions par courants porteurs sur lignes à haute tension ; J. GARCZINSKY ; *Onde Elec.*, août-septembre-octobre 1933.

Les transmissions par courants porteurs sur les lignes à haute tension, J. GARCZINCSKY ; *A. P. T. T.*, juillet 1934, p. 658.

Amélioration de la transmission téléphonique sur les circuits fantômes, par les méthodes à double bande, S. CHAKSAVARTI ; *Onde Elec.*, août 1935, p. 540.

(b) 3. General Rules concerning Transmission Systems for Radio Broadcasting.

Etude de la voix humaine et des sons musicaux au point de vue radiophonique, REYNAUD-BONIN ; *Radio-Revue*, août 1924, p. 125.

Circulaire n° 2.942 de la Section Technique de l'Exploitation Téléphonique concernant les mesures à prendre au sujet de la constitution des liaisons téléphoniques à mettre à la disposition du service de la radio-diffusion ; *Bulletin officiel des P. T. T.*, 1931, n° 1, p. 8.

La télédiffusion, R. DE LANOUVELLE ; *B. S. F. E.*, février 1936, p. 183.

Radiodistribution par courants de haute fréquence, F. GLADENBECK ; *A. P. T. T.*, mai 1936, p. 484.

(b) 4. General Rules concerning Transmission Systems for Picture Transmission.

Optique et radioélectricité, L. BOUTHILLON ; *Onde Elec.*, juillet 1925, p. 287, novembre 1926, p. 577, mars 1927, p. 97.

Quelques procédés d'amplification des courants photoélectriques et applications à l'émission des bélinogrammes, TOULON ; *Onde Elec.*, février 1928.

Derniers progrès de la transmission bélinographique en France, OGLOBLINSKY ; *Onde Elec.*, août 1928.

Transmission des images et fac-similés par le système de la Société (International Telephone and Telegraph Laboratories), P. L., *Génie Civil*, 7 novembre 1931.

La télévision par les tubes à rayons cathodiques, V. K. ZWORYKIN ; *R. G. E.*, 26 mai 1934, p. 720.

L'exploration à vitesse variable en télévision, *A. P. T. T.*, février 1935, p. 116.

Le problème de la télévision à grande distance, G. VALENSI ; *A. P. T. T.*, avril, mai, juin 1935, pp. 301, 401, 501.

L'amplification en télévision, G. KRAWINKEL ; *A. P. T. T.*, septembre 1935, p. 845.

La télévision à l'Exposition Universelle et internationale de Bruxelles (1935), R. BARTHÉLEMY ; *R. G. E.*, 21 septembre 1935, p. 405.

La télévision, ses récents progrès, la nouvelle installation en service à Paris, R. BARTHÉLEMY ; *A. P. T. T.*, mai 1936, p. 409.

Caractéristiques techniques du poste émetteur de télévision de la Tour Eiffel, J. LE DUC et R. BARTHÉLEMY ; *R. G. E.*, 2 mai 1936, p. 651.

(c) 1. Apparatus : Subscribers' Sets.

Sur un nouveau montage de postes à batterie locale utilisant le combiné du poste téléphonique à batterie centrale du modèle administratif, R. BIGORGNE et P. MARZIN ; *A. P. T. T.*, mars 1932.

Etude d'une nouvelle capsule microtéléphonique pour combiné à batterie centrale, P. MARZIN ; *A. P. T. T.*, octobre 1932.

Quelques considérations sur l'évolution et l'état actuel de la technique microphonique, CHAVASSE ; *A. P. T. T.*, janvier 1933.

Amplificateur terminal pour station d'abonné, *B. technique T. T. Suisses*, février 1933.

Le poste téléphonique S. O. S. et de signalisation du Mattloch (route de la Furka), *B. Technique T. T. suisses*, juin 1933.

Nouveau poste d'abonné à batterie locale, R. BIGORGNE et P. MARZIN ; *A. P. T. T.*, février 1934.

Amélioration de l'efficacité des appareils à B. L. type 1910 et à B. C. type 1918 par l'emploi d'embouchures appropriées, CHAVASSE ; *A. P. T. T.*, mai 1934.

Contributions à l'étude du récepteur téléphonique, M. MARINESCO ; *A. P. T. T.*, juillet 1934, p. 631.

(c) 2. Apparatus : Local Telephone Exchanges.

Nouveaux enregistreurs d'impulsions, Laboratoires Hasler S. A., *B. tech. T. T. suisses*, avril 1933.

Nouvelle station à prépaiement pour le service local et interurbain, manuel et automatique, O. MOSER ; *B. techn. T. T. suisses*, août 1933.

Les installations téléphoniques du Chemin de fer de la Jungfrau, *B. tech. T. T. suisses*, octobre 1933.

La distribution des informations parlées dans le réseau téléphonique de Paris, J. ROUVIÈRE ; *A. P. T. T.*, mai 1934, p. 413.

Les centres de transit automatiques et les bureaux automatiques suburbains du réseau téléphonique de Paris, J. ROUVIÈRE ; *A. P. T. T.*, août 1934, p. 705.

Le groupe automatique de Zurich, P. SCHILD ; *B. techn. T. T. suisses*, décembre 1934.

Disque d'appel et qualité de la sélection, J. KAUFMANN ; *B. tech. T. T. suisses*, décembre 1935.

L'automatique rural en France, Y. UZENOT ; *A. P. T. T.*, janv. 1936, p. 1 ; févr. 1936, p. 118 ; mars 1936, p. 222.

(c) 3. Apparatus : Toll Exchanges.

Contribution à la théorie du transformateur téléphonique, J. CARVALLO et RENAULT ; *A. P. T. T.*, septembre 1926, p. 788.

Phénomènes de résonance dans les transformateurs téléphoniques, J. GRANIER ; *R. G. E.*, 27 novembre 1926, p. 789.

Un perfectionnement aux émissions d'appel ; *R. T. T.* et *T. S. F.*, juillet 1929, p. 511.

Note sur les transformateurs téléphoniques, P. CHAVASSE ; *B. S. F. E.*, novembre 1929, p. 656.

Utilisation d'éléments redresseurs à oxyde de cuivre pour la protection contre les chocs acoustiques, L. J. COLLET ; *A. P. T. T.*, avril 1932.

L'appel par impulsions induites sur les lignes téléphoniques équipées de translateurs, *B. Techn. T. T. suisses*, février 1933.

La sélection interurbaine, LUBBERGER ; *B. tech. T. T. suisses*, avril 1933.

La sélection intervilles et le service rapide à Bâle, E. FREY ; *B. tech. T. T. suisses*, décembre 1933.

Comparaison entre les différents modes d'alimentation des grands centraux téléphoniques, A. CHOVET ; *A. P. T. T.*, avril 1934, p. 309.

Le trafic interurbain semi-automatique, K. DOBRSKI ; *A. P. T. T.*, février 1936, p. 93.

(c) 4. Apparatus : Repeater Stations.

Réduction de la variation de l'intensité dans les lampes par l'emploi de résistances en fer ; *R. G. E.*, 24 mars 1923, p. 477.

L'influence de la température sur les tubes thermo-ioniques, COURTINES ; *Onde Elec.*, novembre 1924, p. 521.

Les phénomènes de résistance négative dans les lampes à deux grilles ; production et utilisation du phénomène, P. AMYE ; *Onde Elec.*, juillet 1925, p. 297.

Construction d'amplificateurs de puissance sans distorsion, E. W. KELLOGG ; *Onde Elec.*, novembre 1925, p. 474, et décembre 1925, p. 540.

La théorie de la lampe à 3 électrodes, par Y. DOUCET ; *Q. S. T. et Rad. Elec.*, octobre 1926, p. 36.

Tension de grille négative, par J. MARCOT ; *R. T. T. et T. S. F.*, décembre 1926, p. 970.

Influence des émissions secondaires des métaux sur le fonctionnement des lampes à trois électrodes, LE BOITEUX ; *R. G. E.*, 2 juin 1928.

Sur les amplificateurs à résistances, J. B. POMEY ; *A. P. T. T.*, octobre 1928.

L'amplificateur à lampes et la détection des rayons corpusculaires isolés, Louis LEPRINCE-RINGUET ; *A. P. T. T.*, juin 1931.

Note sur les amplificateurs pour haute fréquence à circuit d'anode accordé et à transformateur, P. MARZIN ; *Onde Elec.*, janvier 1933.

Sur les harmoniques engendrés dans l'amplification par lampes. Notion de coefficient de pureté, BARANOV ; *Onde Elec.*, décembre 1933.

Amplificateur téléphonique duplex, MARIO MANO ; *R. G. E.*, 28 mars 1936, p. 458.

Répéteur de stabilité accrue pour circuit téléphonique à 2 fils, R. BIGORGNE et P. MARZIN ; *A. P. T. T.*, juin 1936, p. 595.

(d) 1. Lines : Open Wire.

Utilisation de fils en alliage d'aluminium pour la construction des lignes téléphoniques, L. DAUMARD ; *A. P. T. T.*, novembre 1932.

Utilisation en Indochine de conducteurs téléphoniques en fils d'aluminium câblés, REUFFLET ; *A. P. T. T.*, novembre 1933.

Utilisation de poteaux en béton armé pour la construction des lignes téléphoniques, L. DAUMARD et M. VAILLAUD ; *A. P. T. T.*, février 1934, p. 105.

Les dépôts de givre et de verglas sur les lignes aériennes, R. DEMOGUE ; *A. P. T. T.*, novembre 1935, p. 965.

(d) 2. Lines : Cable.

Une formule pratique pour la détermination du diamètre des fils d'un câble souterrain destiné à être pupinisé ; *A. P. T. T.*, juin 1924, p. 649.

Progrès et état actuel de la technique des lignes pupinisées, L. CAHEN ; *B. S. F. E.*, août 1924.

La technique de la téléphonie à grande distance par câbles ; *R. T. T. et T. S. F.*, juin 1925, p. 430.

Etude sur l'établissement des canalisations téléphoniques multiples dans Paris, J. MAILLEY ; *A. P. T. T.*, août 1926, p. 703.

La lutte contre la corrosion par les traitements électro-chimiques, M. COURNOT ; *B. S. F. E.*, 1928.

Contribution à la théorie des câbles téléphoniques à paires combinables. Etude de la diaphonie, DUNAND ; *R. G. E.*, 30 octobre 1926, p. 621, et 6 novembre 1926, p. 661.

Ligne artificielle d'équilibre pour ligne pupinisée, J. B. POMEY ; *R. G. E.*, 20 octobre 1928.

Remarque sur les mesures de déséquilibre de capacité des câbles téléphoniques, R. DUNAND ; *R. G. E.*, 20 juillet 1929.

Les bobines Pupin pour les câbles sous-marins ; *R. T. T. et T. S. F.*, juillet 1929, p. 529.

L'emploi des conduites monolithes pour les canalisations téléphoniques souterraines, M. LARRÉ ; *A. P. T. T.*, janvier 1930, p. 25.

La pose mécanique des câbles ; *R. T. T. et T. S. F.*, avril 1930, p. 263.

Le câble téléphonique pupinisé, J. B. POMEY ; *R. G. E.*, 3 mai 1930.

Projets de câbles téléphoniques transatlantiques ; *A. P. T. T.*, mai 1930, p. 444.

Nouveau câble téléphonique franco-anglais ; *Journ. Télégr.*, octobre 1930, p. 265.

Propriétés magnétiques des alliages de nickel, M. BALLEY ; *Revue du Nickel*, octobre 1930.

Développement des câbles à grande distance en France, M. PRACHE ; *B. S. F. E.*, novembre 1930, p. 1178.

Expérience d'un nouveau procédé de construction des conduites multitubulaires sans joint, M. MOINE et M. L. DAUMARD ; *A. P. T. T.*, mars 1931, p. 173.

Les insectes perceurs du plomb ; *La Nature*, 15 juin 1931, p. 563.

Mesures faites sur le câble n° 4/5 du nouveau modèle à une quarte de conducteurs pour travaux provisoires, P. MARZIN ; *A. P. T. T.*, décembre 1932.

Les câbles téléphoniques dans la région de la Jungfrau, *B. Tech. T. T. suisses*, juin 1933.

La détérioration et la protection des gaines de plomb des câbles électriques, NOIRCLER et LUSSAND ; *R. G. E.*, 8 juillet 1933.

Les nouveaux types de charge Pupin pour circuits téléphoniques, H. JANNÈS ; *A. P. T. T.*, novembre 1933.

Note sur la forme des alvéoles dans le système Cravetto, J. CHAMBOLLE ; *A. P. T. T.*, janvier 1934, p. 25.

Câble téléphonique anglo-belge (1932), A. ROSEN ; *A. P. T. T.*, janvier 1934, p. 33.

Les défauts des câbles et leurs causes, R. GERTSCH ; *B. tech. T. T. suisses*, février 1934.

Pose de câbles armés au moyen d'une "charrue-taupe," L. G. SEMPLE et BOOCOCK ; *A. P. T. T.*, juin 1934, p. 539.

Sur les insectes qui perforent les enveloppes en plomb des câbles aériens, W. HORN ; *A. P. T. T.*, juin 1934, p. 559.

Entretien et réparation des câbles téléphoniques souterrains à longue distance, L. SIMON ; *Bulletin d'informations* des *P. T. T.*, 1934, n° 7–8, pp. 11–38.

Sur l'emploi d'une machine spéciale pour la pose des câbles sous les voies publiques, M. JAMBENOIRE ; *A. P. T. T.*, novembre 1934, p. 1021.

Construction des conduites multiples.—Essais effectués pour la comparaison du système de construction en dalles enrobées et du système dit "monolithe," Jean MAILLEY et Jacques CHAMBOLLE ; *A. P. T. T.*, août 1935, p. 705.

Pose de câbles téléphoniques aériens dans la région de Lille, J. DAUVIN ; *A. P. T. T.*, décembre 1935, p. 1045.

La corrosion chimique et électrolytique des canalisations souterraines, M. R. GIBRAT ; *A. P. T. T.*, août 1936, p. 717.

Le câble téléphonique (1935) du détroit de Bass ; *A. P. T. T.*, juin 1936, p. 531.

L'état actuel de la technique des lignes souterraines à grande distance, L. SIMON ; *B. S. F. E.*, septembre 1936.

Le service de maintenance du réseau français des lignes souterraines à grande distance, M. PARMENTIER et R. CROZE ; *A. P. T. T.*, octobre 1936.

(d) 3. Lines : Mixed Lines.

Néant.

(e) Maintenance of Lines and Apparatus.

Sur l'emploi des mesures de capacité pour rechercher et localiser les ruptures de circuits, V. PONS ; *A. P. T. T.*, mars 1926, p. 267.

Méthode proposée pour la localisation des défauts sur les lignes, CHAVASSE et MOCQUARD ; *A. P. T. T.*, novembre 1926, p. 987.

Emploi d'un plan de jonction pour la localisation des dérangements dans les câbles, PRACHE ; *A. P. T. T.*, avril 1929.

Localisation des défauts d'isolement sur les câbles par la méthode du double Murray ou du double Varley, H. JANNÈS et L. S. SIMON, *A. P. T. T.*, juin 1932.

Sur les procédés permettant de vérifier le bon état des cordons dans les centraux téléphoniques, R. BIGORGNE ; *A. P. T. T.*, juillet 1932.

Nouveaux enregistreurs d'impulsions, *B. Technique T. T. suisses*, février 1933.

Elimination des troubles apportés à l'exploitation des lignes téléphoniques par les redresseurs à vapeur de mercure, L. J. COLLET ; *A. P. T. T.*, juin 1933.

La surveillance des courants vagabonds déribés des lignes de traction dans le réseau de Paris, R. DEMOGUE ; *A. P. T. T.*, octobre 1933.

Appareillage pour le contrôle des disques d'appel, J. KAUFMANN ; *B. Techn. T. T. suisses*, février 1934.

(f) Simultaneous or Co-existing Telegraphy and Telephony.

Système de télégraphie par appropriation du combiné avec retour par le sol, utilisé par l'administration allemande ; voir *Compte rendu Assemblée Plénière C.C.I.*, Paris, 1926, pp. 301 et 302.

Système de télégraphie par appropriation des circuits téléphoniques employé par l'administration allemande (Système Siemens et Halske) ; voir *Compte rendu Assemblée Plénière C.C.I.*, Paris, 1926, pp. 303 à 308.

Système de télégraphie à courants porteurs de fréquences vocales employé par l'administration allemande (système Siemens et Halske) ; voir *Compte rendu Assemblée Plénière C.C.I.*, Paris, 1926, pp. 309 à 315.

Note sur l'élimination des perturbations causées par les lignes exploitées au Baudot, BOYER ; *A. P. T. T.*, octobre 1928.

Emission d'un courant télégraphique sur un câble pupinisé, J. B. POMEY ; *R. G. E.*, 19 avril 1930, p. 605.

Etude de la vitesse maximum de transmission d'une liaison télégraphique, L. J. COLLET ; *A. P. T. T.*, mars 1930, p. 197.

Propagation du courant télégraphique sur un câble, J. B. POMEY ; *R. G. E.*, 29 août 1931, p. 317.

L'exploitation au télégraphe des câbles téléphoniques à grande distance, R. LEROY ; *A. P. T. T.*, septembre 1934, p. 847.

(g) Co-ordination of Radiotelephony and Telephony.

Exposé critique des théories de la propagation, L. BOUTHILLON ; *Onde Elec.*, mai 1923, p. 275, juin 1923, p. 345.

Perturbations solaires et ondes électromagnétiques, L. BOUTHILLON ; *A. P. T. T.*, 1923, p. 1432.

Longueur d'onde optimum en radiocommunication, L. BOUTHILLON ; *R. G. E.*, 17 mai 1924, p. 914.

Note sur la modulation dans les appareils récepteurs, H. DE BELLECISZE ; *Onde Elec.*, avril 1926.

Transmission en ondes courtes, H. CHIREIX ; *Onde Elec.*, juin 1926.

Dispositif alternant les effets du (fading). Application et conséquences, H. DE BELLECISZE ; *Onde Elec.*, mars 1927.

Dispositif antiparasite, DE BELLECISZE ; *Onde Elec.*, mars 1927.

Influence de la nature du sol sur l'émission et la réception radioélectriques, L. BOUTHILLON ; *Onde Elec.*, 1927, p. 533.

Compensation des courants induits entre antennes émettrices voisines, VILLEM ; *R. G. E.*, 24 mars 1928.

La direction des ondes radio-électriques. Idées et réalisations récentes, L. BOUTHILLON ; *B. S. F. E.*, 1928, p. 657. (Analyse dans *R. G. E.*, 16 juin 1928, p. 1017).

La transmission radiotéléphonique par ondes courtes dirigées et la station d'essais de communication Paris-Alger, R. VILLEM ; *R. G. E.*, 16 juin 1928, p. 1043.

Liaisons radiotéléphoniques à grande distance par ondes courtes projetées, H. CHIREIX ; *B. S. F. E.*, juillet 1928.

Systèmes français d'aériens projecteurs pour émissions sur ondes courtes, H. CHIREIX ; *B. S. F. E.*, mai 1929.

Liaison radiotéléphonique Paris-Buenos-Ayres par ondes courtes projetées, VILLEM ; *B. S. F. E.*, octobre 1929.

La liaison radiotéléphonique Paris-Buenos-Ayres par ondes courtes projetées, R. VILLEM ; *A. P. T. T.*, janvier 1930, p. 62, février 1930, p. 155.

La liaison radiotéléphonique Paris-Buenos-Ayres par ondes courtes projetées, R. VILLEM ; *R. G. E.*, janvier 1930, p. 1, février 1930, p. 17.

Notions générales de transmission appliquées à la Radiotéléphonie, Ph. LE CORBEILLER et G. VALENSI ; *Onde Elec.*, avril 1930.

Expériences de communication radiotéléphonique sur ondes très courtes entre la Corse et le continent, G. A. BEAUVAIS ; *A. P. T. T.*, avril 1930.

La liaison radiotéléphonique Madrid-Buenos-Ayres, E. M. DELORAINE ; *Onde Elec.*, octobre 1930.

La liaison radiotéléphonique Madrid-Buenos-Ayres ; *A. P. T. T.*, novembre 1930.

L'élimination des perturbations radioélectriques, M. ADAM ; *R. G. E.*, 11 avril 1931, p. 591.

Le système des communications radiotéléphoniques à bande latérale unique appliqué aux ondes courtes, A. M. REEUZ ; *R. G. E.*, 12 et 19 septembre 1931, p. 105.

Réflecteurs et lignes de transmission pour ondes ultra courtes, DARBORD ; *Onde Elec.*, février 1932.

Modulation et bandes latérales. Relation entre la modulation en amplitude et la modulation en fréquence, HECHT ; *Onde Elec.*, mars 1932.

La diffusion téléphonique des programmes de la Radiodiffusion, MOSER ; *Journ. Télégr.*, avril 1932.

Les nouveaux centres radioélectriques de Pontoise et Noiseau, E. PICAULT ; *R. G. E.*, 9 et 16 avril 1932.

La transmission radiotéléphonique à ondes courtes à bande latérale unique et autres systèmes, E. M. DELORAINE ; *B. S. F. E.*, septembre 1932.

La réception synchrone, H. DE BELLECISZE ; *Onde Elec.*, juin, juillet, août 1932.

Les amplificateurs pour bandes de fréquences, DROUIN ; *Onde Elec.*, mai, juin, juillet, août 1932.

Etude des régimes transitoires et des constantes de temps pour les principaux circuits utilisés en T. S. F., V. ROCARD ; *Onde Elec.*, septembre-octobre 1932.

La liaison radiotéléphonique par ondes très courtes entre le continent et la Corse, PICAULT ; *R. G. E.*, 8 octobre 1932.

Les oscillateurs à fréquence très élevée et les radio-communications par ondes très courtes, G. GUTTON ; *R. G. E.*, 17 septembre 1932.

La liaison radiotéléphonique entre la Corse et le continent par ondes très courtes, BRAMEL et CLEJOULX ; *A. P. T. T.*, janvier 1933.

Les liaisons radioélectriques à grande distance par ondes courtes, WILLEM ; *Onde Elec.*, novembre, décembre 1932.

Radiodiffusion expérimentale sur onde de 7 m. 85 à Amsterdam, NORDLOHN ; *Onde Elec.*, janvier 1933.

Dix ans de radiodiffusion, FLEURY ; *Onde Elec.*, novembre, décembre 1932.

La qualité en radiotéléphonie, P. DAVID ; *R. G. E.*, 4 février 1933.

L'exploitation des communications radiotéléphoniques, PICAULT ; *Onde Elec.*, novembre, décembre 1932.

Les ondes de moins de 10 mètres, BEAUVAIS ; *Onde Elec.*, novembre, décembre 1933.

Système de liaison à magnétrons par ondes extra courtes, *B. S. F. R.*, janvier, février 1933.

Contribution expérimentale à l'étude de la propagation des ondes courtes, MAIRE ; *Onde Elec.*, janvier 1933.

Congrès international d'Electricité de 1932. Travaux de la 9e section (phénomènes de haute fréquence), G. GUTTON, P. DAVID ; *R. G. E.*, 3 décembre 1932. Reproduit dans *A. P. T. T.*, juin 1933.

Propriétés des gaz ionisés dans les champs de haute fréquence, GUTTON ; *Onde Elec.*, février 1933.

Service radiotéléphonique mobile, *C. F. R., Journal Télégr.*, juin 1933.

Le champ électromagnétique à distance (ondes courtes), *Journal Télégr.*, avril 1933.

Théorie élémentaire du système de modulation multiple d'une oscillation à haute fréquence, FAYARD, *Onde Elec.*, juin 1933.

Etude du fonctionnement d'un auto-oscillateur perturbé par une onde extérieure de fréquence peu différente de la sienne, E. SUBRA ; *A. P. T. T.*, septembre 1933.

Liaison radiotéléphonique France-Algérie, RIGAL ; *A. P. T. T.*, décembre 1933.

Le champ électromagnétique à distance. Ondes courtes. *T. G., Journal télégr.*, décembre 1932 ; reproduit dans *A. P. T. T.*, décembre 1933.

Vue d'ensemble sur les divers procédés employés pour augmenter le rendement des émetteurs de radiodiffusion, J. LOEB ; *A. P. T. T.*, février 1934, p. 132.

Télédiffusion à programmes multiples, *B. Techn. T. T. suisses*, février 1934.

La protection des réceptions de radiodiffusion contre les parasites industriels, P. BAIZE ; *A. P. T. T.*, mars 1934, p. 201.

Perturbations apportées au service des communications radioélectriques par les lignes de distribution d'énergie, Ch. BRUNIAUX et R. PETIT ; *A. P. T. T.*, mars 1934, p. 222.

Le développement et l'organisation de la radiodiffusion française, Michel ADAM ; *R. G. E.*, 10 mars 1934, p. 323.

Les perturbations radioélectriques. La situation des entreprises électriques en France, au regard du décret du 1er décembre 1933, J. CAZALS DE FABEL ; *R. G. E.*, 24 mars 1934, p. 405.

La liaison radioélectrique par ondes ultra-courtes entre Lympne et Saint-Inglevert, A. CLAVIER et L. C. GALLANT ; *R. G. E.*, 7 avril 1934, p. 475.

Les communications radiotéléphoniques, E. PICAULT ; *R. G. E.*, 2 juin 1934, p. 737.

Stabilisation des fréquences par le quartz, R. JOUAUST ; *R. G. E.*, 30 juin 1934, p. 873.

Liaison radiotéléphonique d'essai entre un train en marche et le réseau téléphonique, A. LABROUSSE et A. BECQ ; *A. P. T. T.*, juin 1934, p. 501.

Recherches sur la construction de circuits pour courants de haute fréquence (jusqu'à 100 000 p : s), H. JANNÈS et P. MARZIN ; *A. P. T. T.*, juillet 1934.

Note sur la recherche et la suppression des parasites de T. S. F. produits par les lignes d'énergie, Emile BOYER ; *A. P. T. T.*, août 1934, p. 771.

Les communications radiotéléphoniques, E. PICAULT ; *Onde Elec.*, octobre 1934, p. 386.

Dispositif antiparasite pour téléimprimeur Creed, H. SUBRA ; *A. P. T. T.*, octobre 1934, p. 970.

Considérations sur la détection, M. CHAUVIERRE ; *Onde Elec.*, décembre 1934, p. 524.

La propagation des ondes radio-électriques, FRANK E. SMITH ; *A. P. T. T.*, décembre 1934, p. 1085.

Réunion de l'Union radioscientifique internationale (Londres, septembre 1934), E. PICAULT ; *R. G. E.*, 13 juillet 1935, p. 45.

Notes sur les questions traitées à la Xe Assemblée plénière du C.C.I.F.—Coordination de la téléphonie et de la radiotéléphonie, A. LABROUSSE ; *A. P. T. T.*, août 1935, p. 756.

Les communications radioélectriques, H. DE BELLECISZE ; *Onde Elec.*, juin-juillet, août, octobre, novembre 1935.

Les travaux du Comité mixte des perturbations radioélectriques (Berlin, 8-14 avril 1935), R. JOUAUST ; *R. G. E.*, 19 octobre 1935, p. 525.

La radiodistribution dans quelques pays européens, *A. P. T. T.*, octobre 1935, p. 921.

Note sur la propagation des ondes de 24,56 mètres et 33 mètres sur le parcours Alger-Paris, PICAULT et ESPINASSE ; *B. S. F. E.*, décembre 1935, p. 1229.

Etude des régulateurs de niveau et dispositifs (antifading), Georges ESPINASSE ; *A. P. T. T.*, décembre 1935, p. 1098.

Note sur la propagation des ondes de 18,48 mètres et 31,19 mètres sur le parcours Saïgon-Paris, PICAULT et ESPINASSE ; *B. S. F. E.*, décembre 1935, p. 1226.

Le contrôle des phénomènes transitoires dans les transmissions radiophoniques, E. DIVOIRE ; *Onde Elec.*, janvier 1936, p. 40.

Sur un dispositif de manipulation télégraphique et de modulation des postes émetteurs radioélectriques de grande puissance, M. MICHEL ; *A. P. T. T.*, janvier 1936, p. 47.

Progrès dans l'élimination des perturbations radioélectriques, Michel ADAM ; *R. G. E.*, 8 février 1936, p. 231.

Propagation des ondes utilisées en radiodiffusion et antennes "anti-fading," J. LOEB ; *A. P. T. T.*, avril 1936, p. 313.

L'origine des échos de longue durée (Echos de Hals), J. FUCHS ; *A. P. T. T.*, avril 1936, p. 346.

L'acoustique des studios, W. FURRER ; *B. techn. T. T. suisses*, avril et juin 1936.

Les récents progrès de la radiotechnique (Exposition de T. S. F., Paris, février 1936), Michel ADAM ; *R. G. E.*, 9 mai 1936, p. 689.

L'émetteur de radiodiffusion de Lyon-Tramoyes, M. BARROUX ; *A. P. T. T.*, juillet 1936, p. 613.

Liaison radiotéléphonique France-Algérie, R. RIGAL ; *A. P. T. T.*, août 1936, p. 744.

Etude sur les parasites radioélectriques produits dans certains cas par les installations téléphoniques rurales, G. LETELLIER ; *A. P. T. T.*, août 1936, p. 767.

(h) Measurements : Methods and Apparatus.

Méthodes d'essais des appareils téléphoniques. Postes d'abonnés, microphones, récepteurs ; *B. S. F. E.*, décembre 1923, p. 671.

Sur un dispositif de modulomètre utilisable pour le contrôle des émissions radiotélégraphiques, A. BLONDEL ; *Comp. rend. Acad. Sciences*, 14 sept. 1925, p. 345.

Comment localiser l'humidité dans les câbles ; *R. T. T. et T. S. F.*, août 1924, p. 260.

Procédé pour localiser les pertes à la terre dans un câble souterrain ; *R. T. T. et T. S. F.*, décembre 1924, p. 944.

Quelques considérations d'ordre pratique sur l'emploi du pont de Wheatstone en courant alternatif, par J. CARVALLO ; *R. G. E.*, 28 février 1925, p. 337.

Etalonnage d'un système thermo-élément-galvanomètre, ABADIE ; *Onde Elec.*, avril 1925, p. 133.

Instruments de mesures de courants alternatifs employés en téléphonie, P. KASPAREK ; *A. P. T. T.*, mai 1925, p. 461.

Appareils de mesures des courants alternatifs de faible intensité, BETHENOD ; *B. S. F. E.*, mai 1925, p. 470.

Mesure, aux fréquences téléphoniques, de la fréquence propre d'une bobine d'inductance (variomètre), UNKIYAMA et KOBAYASHI ; *A. P. T. T.*, mai 1925, p. 505.

Un nouvel oscillographe électromagnétique à grande sensibilité, R. DUBOIS ; *R. G. E.*, 20 juin 1925, p. 977.

Henrymètres, capacimètres, tellurohmmètres, R. BARTHÉLEMY ; *Onde Elec.*, juin 1925, p. 419.

Sur l'application des thermo-couples à la mesure des courants alternatifs de fréquence musicale, P. CHAVASSE ; *A. P. T. T.*, juillet 1925, p. 662.

Un nouvel oscillographe électromagnétique et son application aux mesures en courant alternatif, R. DUBOIS ; *A. P. T. T.*, août 1925, p. 709.

Nouveaux appareils pour la mesure directe des résistances, fréquences, différences de phases, températures, etc., S. HELD ; *R. G. E.*, 10 octobre 1925, p. 611.

Nouveau fréquencemètre à échelle très étendue, A. CAMPBELL ; *A. P. T. T.*, février 1926, p. 166.

Perfectionnement aux méthodes potentiométriques utilisées en courant alternatif, A. PAGÈS ; *R. G. E.*, 6 mars 1926, p. 381.

La mesure de la diaphonie sur les circuits téléphoniques, Maria PRUDHON ; *R. G. E.*, 5 février 1927, p. 205.

Les essais téléphonométriques des appareils d'abonnés, P. CHAVASSE ; *B. S. F. E.*, mars 1928.

Nouvelle méthode de mesure de la résistance des prises de terre, P. MOCQUARD ; *A. P. T. T.*, décembre 1929, p. 1085.

Méthode et appareils de mesure des déséquilibres de câbles téléphoniques, R. DUNAND ; *B. S. F. E.*, novembre 1929, p. 1213.

Les deux fonctions fondamentales du vibromètre et son application à l'électro-acoustique, K. KOBAYASHI ; *A. P. T. T.*, décembre 1930, p. 105.

Applications de l'électricité à l'étude de l'isolement phonique des matériaux et des bâtiments, M. J. F. CELLERIER ; *B. S. F. E.*, juillet 1931, p. 593.

Mesure des intensités sonores par la méthode des scintillations, F. CANAC ; *Journ. Phys. et Rad.*, février 1931, p. 92.

Un dispositif simple pour la mesure des petites forces électromotrices continues sans débit notable, étude de MM. J. GALOSO et COURTINES ; *R. T. T. et T. S. F.*, février 1931, p. 157.

Appareils établis par le service d'études et de recherches techniques des P. T. T., R. BIGORGNE ; *B. S. F. E.*, novembre 1931.

Note sur les bruits et leur mesure, P. CHAVASSE ; *A. P. T. T.*, janvier 1932.

La mesure et l'analyse des bruits produits par les machines électriques, M. P. BARON ; *B. S. F. E.*, novembre 1932.

Etude des bruits et de l'isolement phonique des matériaux et des bâtiments, J. P. CELLERIER ; *R. G. E.*, 29 octobre 1932.

Matériel transportable permettant de mesurer par lecture directe les équivalents de référence des liaisons téléphoniques, R. BIGORGNE ; *A. P. T. T.*, novembre 1932.

Compte rendu des travaux et recherches du Laboratoire national de Radioélectricité au cours de l'année 1932, G. GUTTON ; *A. P. T. T.*, mars 1933.

La stabilisation des fréquences et leur mesure précise, DÉCAUX ; *Onde Elec.*, novembre, décembre 1932.

Sur la définition et la mesure de la résistance d'une prise de terre, R. BIGORGNE et P. MARZIN ; *A. P. T. T.*, avril 1933.

La localisation des ruptures des câbles sous-marins par des mesures au faux zéro, M. BAYARD ; *A. P. T. T.*, juin, 1933.

Méthodes électriques de production et de mesure des fréquences musicales, P. NICOLAS ; *Revue d'acoustique*, mars 1933.

Méthodes subjectives et mesures des bruits, P. BARON ; *Revue d'acoustique*, mars 1933.

Bruits en téléphonie, leur effet perturbateur et leur mesure, *Journ. Télégr.*, juillet 1933.

Les mesures radioélectriques au Laboratoire national de Radioélectricité, *A. P. T. T.*, juillet, août, septembre, novembre 1933.

Capacimètre phonique à lecture directe, M. DUREPAIRE ; *R. G. E.*, 15 juillet 1933.

Nouvel ondemètre de précision pour ondes courtes, B. KLEEBINDER ; *Radio-amateur*, août 1933.

Détection de phénomènes simultanés par dispositifs à lampes triodes, L. LEPRINCE-RINGUET ; *A. P. T. T.*, janvier 1934, p. 63.

Sur la mesure de la sonorité et de l'isolement acoustique, P. CHAVASSE ; *A. P. T. T.*, janvier 1934, p. 1.

Travaux et Recherches du Laboratoire national de Radioélectricité au cours de l'année 1933, G. GUTTON ; *A. P. T. T.*, février 1934, p. 89.

Mesure de bruits, BAKOS et KAGAN ; *A. P. T. T.*, février 1934, p. 145.

Appareils pour la mesure objective et analyse des bruits (sonomètres), *A. P. T. T.*, mars, avril 1934, pp. 246, 359.

Vocabulaire d'acoustique, *A. P. T. T.*, avril 1934, p. 380.

Sur des domaines d'oscillations des triodes génératrices d'ondes ultracourtes, E. PIERRET ; *R. G. E.*, 9 juin 1934, p. 784.

Méthode de mesure des tensions statiques à partir de 0,1 volt à l'aide d'un appareil transportable n'utilisant qu'un voltmètre comme appareil de mesure, H. SUBRA ; *A. P. T. T.*, septembre 1934, p. 879.

Dollis Hill, Service des recherches et de l'enseignement professionnel du Post Office britannique, B. S. COHEN ; *A. P. T. T.*, octobre 1934, p. 793.

Un nouveau pont pour mesurer le module et l'argument d'une impédance en courant alternatif, M. GRÜTZMACHER ; *A. P. T. T.*, novembre 1934, p. 950.

La distorsion non-linéaire en électro-acoustique appliquée, I. PODLIASKY ; *A. P. T. T.*, janvier 1935, p. 1.

Utilisation du quartz piézoélectrique pour l'étude des pressions variables et des vibrations à fréquences élevées, A. LANGEVIN ; *R. G. E.*, 5 janvier 1935, p. 3.

La résistance des prises de terre, F. WITZ ; *R. G. E.*, 26 janvier 1935, p. 123.

Boîte portative d'essais de transmission, R. BIGORGNE et P. MARZIN ; *A. P. T. T.*, février 1935, p. 170.

Travaux et recherches du Laboratoire national de Radioélectricité au cours de l'année 1934, G. GUTTON ; *A. P. T. T.*, février 1935, p. 205.

Sur la mesure de l'équivalent d'un circuit interrégional, R. BIGORGNE et P. MARZIN ; *A. P. T. T.*, mars 1935, p. 283.

Appareil pour la mesure du degré de gravité des perturbations radioélectriques, H. SUBRA ; *A. P. T. T.*, avril 1935, p. 368.

Nouveau galvanomètre à résonance, H. A. VUYLSTEKE ; *R. G. E.*, 27 avril 1935, p. 537.

Bathymètre pour dicordes, R. BIGORGNE et P. MARZIN ; *A. P. T. T.*, mai 1935, p. 474.

L'acoustique dans l'architecture, D. A. KIRCHNER ; *A. P. T. T.*, mai, juin, juillet 1935, pp. 455, 534, 624.

Lampe stabilisatrice de tension (stabilovolt), R. HIGONNET ; *R. G. E.*, 17 août 1935, p. 247.

Le centre de mesures et de contrôle des émissions radioélectriques, G. ESPINASSE ; *A. P. T. T.*, septembre 1935, p. 808.

Localisation des défauts dans les câbles souterrains en cas de détérioration de tous les conducteurs, S. ISAACSON ; *R. G. E.*, 12 octobre 1935, p. 501.

L'élimination des courants parasites dans les mesures de localisation des défauts d'isolement, L. SIMON ; *A. P. T. T.* octobre 1935, p. 823.

Note sur la mesure des constantes d'une lampe à trois électrodes, J. B. POMEY ; *A. P. T. T.*, novembre 1935, p. 989.

Les méthodes d'étude de la corrosion, Nathalie GOLDOWSKI ; *A. P. T. T.*, novembre 1935, p. 1002.

Influence de la résistance interne et du coefficient d'amplification de la lampe sur l'amplification et la sélectivité, P. BESSON ; *A. P. T. T.*, janvier 1936, p. 72.

L'emploi du dispositif Schlumberger dans l'étude de l'électrolyse des canalisations souterraines, R. GIBRAT ; *R. G. E.*, 11 janvier 1936, p. 51.

Travaux et recherches du Laboratoire national de Radioélectricité au cours de l'année 1935, C. GUTTON ; *A. P. T. T.*, mars 1936, p. 213.

Progrès récents dans les recherches relatives aux microphones à charbon, F. S. GOUCHER ; *A. P. T. T.*, mars 1936, p. 289.

Montage d'essai pour les mesures aux fréquences radioélectriques, E. FROMY ; *R. G. E.*, 25 avril 1936, p. 611.

Les perfectionnements récents des tubes à vide, B. DECAUX ; *A. P. T. T.*, juillet 1936, p. 665.

Note sur le fonctionnement des haut-parleurs électrodynamiques, W. MEZEY ; *Onde Elec.*, août 1936, p. 486.

PART III.

RECOMMENDATIONS CONCERNING QUESTIONS OF OPERATING AND TARIFFS

PAGE 546.

At the end of section (d) "Financial Arrangements" (commencing on p. 545), add the following paragraph :—

If a country situated outside Europe which has (1) small telephone relationship with the other countries adherent to the C.C.I.F. and (2) a small internal telephone development, considers itself justified in asking for its classification in a class below that which would result from the application of the above rules, it should send its request to the Secretariat of the C.C.I.F. giving its justifications for such re-grading and specifying the new class in which it desires to be included from the point of view of financial contribution to the C.C.I.F. In such a case the Auditors would come to a provisional decision, conditional upon its ratification by the next Plenary Meeting.

PAGE 556.

RECOMMENDATION No. 4.

Establishment of the Nomenclature of the International Circuits and the Schematic plan of the Cables.

Add after the fourth paragraph and before the heading "Column 1. Designation of Circuits,"

To avoid discrepancies through information being supplied by two Administrations or Operating Companies for any one circuit, the technical services of the two countries concerned should first agree as to the numerical values (of overall attenuation, etc.) before forwarding them to the International Telecommunication Union.

Amend the sentence under the section headed "Column 3. Length of Successive Homogeneous Sections in Each Country (km)" to read as follows :—

Column 3 should include the length of each homogeneous section of the circuit expressed to the nearest kilometre.

PAGE 557.

Add at the end of the list under section headed "Column 5. Nature of Circuits,"

Carrier circuit ... ... cp.

Amend section headed "Column 7. Coil Loading or Continuous Loading" so that the 3rd line of the 1st paragraph reads:—

spacing should be shown in kilometres to the third decimal point :—

e.g. (103 mH/km
(D = 1.660 km

Add to the section headed "Column 8. Cut-off Frequency (p : s)" the following paragraph :—

If a section of the circuit consists of a carrier circuit and therefore the band of frequencies effectively transmitted by this section is limited by low pass filters, the maximum frequency effectively transmitted is shown in periods per second followed by an asterisk.

Amend section headed " Column 9. Equivalent (at 800 p : s) *" to read as follows :—*

This column is divided into two parts. On the left the transmission equivalent at 800 periods per second is shown in nepers to two places of decimals the second figure being 5 or 0, and on the right this figure is shown in decibels to one decimal place, the figure of which is 5 or 0. For each circuit the nomenclature must give both the number of nepers and the number of decibels."

PAGE 558.

Amend the table of " Appendix 1 *" as follows :—*

Column 5. *First entry under Great Britain should read "* 4*f. cp."*
Column 7. *The second entry should read "* Type 2." *The last entry should read "* $D = 1.83$ *km."*
Column 9. *The two entries should read "* 0.8 *" (neper) and "* 6.95 *" decibels.*
Column 11. *Last entry should read "* $\frac{2f}{2f}$ $\frac{2f}{2f}$ $\frac{4f}{4f}$ *"*

PAGE 560.

After the table and before " Recommendation No. 5*," add the following paragraph :—*

When the International Telecommunication Union considers that the size of the map is too small to allow of all the cables in Europe being shown clearly, the single map will be replaced by an atlas, the first page of which will show a schematic of the whole of the international cable network in Europe.

PAGE 566.

RECOMMENDATION No. 10.

Emergency Lines.

Insert after the sixth line, " That the use of emergency lines . . .*," the following :—*

That the traffic routed via the emergency circuit is usually a very small percentage of the total ;

That determining the charges for the emergency circuit is often the cause of considerable correspondence, and causes delay in the settlement of international accounts ;

That it is necessary for the terminal country responsible for the accounts to know which itinerary was used in the emergency routing,

and after the phrase " Unanimously recommends*," replace the existing text as far as "* Recommendation No. 11*," by the following :—*

1. That the Administrations and Operating Companies concerned should come to an understanding as to the line or lines to be used as emergency lines in case of interruption or breakdown of the normal service, and that lines should be regarded as emergency lines only when they cross countries not used by the normal or auxiliary routes ;

2. That the list of such lines should be revised from time to time at the Plenary Meeting of the C.C.I.F. Modifications or additions to the list of emergency lines which may be made between any two such revisions will be notified to the S.G. of the C.C.I.F. who, in turn, will notify the Administrations and Operating Companies ;

3. That the rates to be charged when these lines are utilised should be the same as for normal lines.

4. That Administrations and Operating Companies agree among themselves to allow the mutual use, free of charge, of emergency routes crossing their respective territories, this agreement, however, leaving them free to make a charge for services rendered when they observe that the use of the emergency routes ceases to be exceptional and temporary.

This exceptional charge shall be made each time the continuous use of an emergency route exceeds a period of 24 hours whatever the amount of traffic concerned.

Furthermore, if the amount of traffic using the emergency route necessitates a direct circuit being employed, this exceptional charge shall be made whatever the duration of the interruption of the normal and auxiliary routes.

The exceptional charge, unless otherwise agreed between the parties concerned, shall be calculated as in 4b.

If a country refuses to participate in the agreement for free use of emergency routes, it may make a transit charge for the use of an emergency circuit crossing its territory. For this purpose the transit exchange, or if necessary the originating terminal exchange routing a call via an emergency circuit which traverses a country which is not a party to the agreement for the free use of emergency routes, shall send by post to the country of destination which is responsible for the accounting given in the following form. The country of destination will take such tickets into consideration when making up its international accounts.

MODEL OF FORM.

Use of an Emergency Route.

The.....Exchange (transit exchange) advises the.....Exchange (exchange of destination) that a call from.....(originating exchange) for..... (called subscriber's exchange) on.....(date) from..... (time) to.....(time) was routed via the international circuits :—

From.....To.....

From.....To.....

Transit exchange which has filled up the form sent to the exchange of.....(exchange of destination).

4 bis. In the case of a call between a country agreeing to the free use of emergency routes and a country not so agreeing, the payment for the call is divided as follows :—

Assuming that countries 1 to 9 on the sketch below conform to the agreement for the free use of emergency routes and that the call is made from A (country 1) to B (country 12), the normal route passing through C and the emergency route passing through D, E and F.

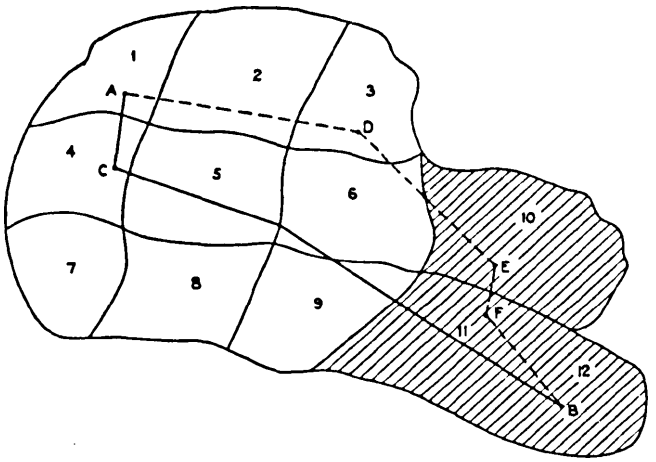
The total payment received by A is divided into two parts, one for the part of the route from A to the point where the normal route leaves the territory where free use of the emergency route is recognised, the other part being allocated to the portion of the route continuing on to B. The first part is normally divided between the countries involved from A and the far side of 9 (limit of the free agreement zone) as if the normal route had been used.

The second part (from the far side of 9 to B) is divided among the countries on the emergency route from the far side of 6 to B in the following proportions :—

(*a*) The hypothetical payment for country 12 (country of destination) is equal to the terminal payment for the first zone of that country with regard to country 6.

(*b*) The hypothetical payments for the other countries along the emergency route including country 10 (the first country outside the group where free use of emergency lines is agreed) are calculated in proportion to the crow-fly length of circuit used in the emergency route, supplemented by the charge for a transit exchange.

5. That the Administrations and Operating Companies give instructions with regard to the constitution of the direct emergency lines when the network lay-out allows it, and when impossible



THE ZONE ADMITTING FREE USE OF EMERGENCY LINES IS SHOWN IN WHITE. NORMAL ROUTE IS SHOWN BY A FULL LINE, AND THE EMERGENCY ROUTE BY A BROKEN LINE.

the head of the terminal exchange will endeavour to deal with the traffic in such a manner that the maximum waiting time laid down by the C.C.I.F. (Recommendation No. 3) is not exceeded.

PAGE 572.

Replace Recommendation Nos. 14, 15 *and* 16 *on pages* 572, 573, 574, *and* 575 *by the following :—*

RECOMMENDATION No. 14.
Subscription Calls.

The International Telephone Consultative Committee—
Unanimously recommends :—

That the following " guiding principles " should be followed in admitting and in fixing charges for subscription calls, and that consequently Articles 12 and 30, paragraph 5 of the Telephone Regulations attached to International Telecommunication Convention, Madrid 1932, should be defined or amplified.

I. CONDITIONS OF ADMISSION.

A subscription is made for a minimum period of one month, the subscriber having the power to renounce the use of his subscription any one day of the week, the day being the same each week and being specified in advance when the subscription is being taken out.

No rebate can be allowed if the subscriber renounces his call for several days of the week.

Nevertheless, by special agreement between the Administrations or Operating Companies concerned, subscription calls can be agreed to for one or more complete periods of seven consecutive days commencing from a certain date and not renewable automatically. In this case, however, no rebate is permitted if any one seance is renounced.

Subscription calls are usually admitted without restriction as to duration. During the heavy traffic period, however, excepting always the busy hours (to be mutually agreed upon by the two terminal exchanges concerned), it is only under one of the following conditions that the duration of a subscription call is unrestricted :—

(*a*) When a circuit is available.

(*b*) When the average delay at the time fixed for the call does not exceed or does not seem likely, by reason of the subscription call, to exceed the following :—

15 minutes for circuits under 500 km in length.
30 ,, ,, ,, from 500 km to 1 000 km in length.
45 ,, ,, ,, over 1 000 km in length.

II. Charges.

Subscription calls are charged as follows :—

(*a*) During the light traffic period : At the highest, a charge which is half that made for an ordinary call during the heavy traffic period.
(*b*) During the heavy traffic period : A charge similar to that for an ordinary call of the same duration made during the heavy traffic period ; however, during certain busy hours, to be fixed for each connection by the Administrations or Operating Companies concerned, up to double the charge for an ordinary call of the same length made during the heavy traffic period may be made.*

The monthly rate of the subscription is calculated on a thirty-day basis, but if the subscriber agrees in advance to forego his concession for one specified day in each week, the calculation may be made on a twenty-five-day basis.

III. Contract between exchanges and subscribers for Subscription Calls.

Arrangements for subscription calls are made by telephone, during the light traffic period, between the terminal exchanges, and confirmation is sent by the exchange demanding the facility to the other terminal exchanges concerned, the latter if necessary passing the information on to other exchanges in their country which have to assist in establishing the call. This written confirmation is worded as follows :—

Confirmation of the agreement relative to the subscription call admitted the.....19.....

A call of.....minutes must be set up every day except (1).....o'clock (legal time) from .....(2).....between subscriber No.....at.....and subscriber No.....at .....to the.....(date).....19.....

In confirmation

.....exchange, the.....day of.....19.....

Signed.....

Typical Form of Subscription Contract (Front)

The Telephone Administration or Operating Company of.....(country of origin). Subscription for International Telephone Service.

The undersigned.....residing at.....agrees to pay until further notice, according to the conditions set out overleaf, the monthly subscription detailed below beginning from.....

Network and Telephone Number.		Time at which the connection is to be established.[1]	Duration of Call.	The day in each week on which the communication is not to be established.	Monthly Tariff.
Caller.	Called.				

Made at.....the.....19.....

*Legal time of the country where the subscription is made.

(1) Insert the name of the day in each week on which the subscriber does not require the call.
(2) Insert the name of the country where the subscription call has been agreed to.

[1] If the subscription call contract is for a period of 7 consecutive days it is necessary to modify this form accordingly.

* See Recommendation No. 45 concerning charges for subscription calls between 16 hours and the commencement of the light traffic period. (White Book, Vol. v, pp. 101 and 102, English edition p. 600.)

Typical Form of Subscription Contract (Back)

General Conditions of the subscription.

ART. I.—Subscription calls are those which should take place daily (except for one day in the week (the same day each week) which is specified beforehand in the subscription contract) between the same stations, at the same previously agreed hour, for the same length of time, and for one month at least.

The duration of the subscription contract is extended from month to month by mutual consent.

The subscription can be cancelled after the first month by either party by notice given eight days before the expiration of the current month of the subscription.

ART. II.—The subscription calls must exclusively concern the personal business of the correspondents or that of their establishments.

ART. III.—The minimum duration of a subscription call is three minutes. Calls of a greater duration than six minutes can be allowed if the normal traffic on the circuits used permits this.

ART. IV.—Subscription calls are subject to the following charges :—

(*a*) During the period of light traffic*: Half the unit rate for ordinary calls of the same duration during the heavy traffic period.

(*b*) During the heavy traffic period(†): The rate for an ordinary call of the same duration during the heavy traffic period (However between.....and.....o'clock double this charge is made(‡).)

The monthly subscription is calculated on a 30-day basis. If the subscriber, however, gives up the use of his subscription during one and the same day in each week, the calculation can be made on the basis of 25 days.

The subscription is payable in advance.

Further reductions in the charge, should the subscriber give up the use of his subscription on several days of the week, are not permitted.

ART. V.—The subscription can be contracted from any date, but the monthly period only counts from the first of each month. The amount of subscription corresponding to the first monthly period may be increased, if necessary, by the part of the subscription corresponding to the period between the date of its coming into force and that of the commencement of the monthly period.

ART. VI.—The connection is to be officially established between the two stations indicated in the contract and at the exact time specified if, at this time, there is a circuit between the terminal stations concerned a circuit which is disengaged and which is not required for an urgent Government call or lightning call (or where urgent Government calls are not admitted, an ordinary Government call). Otherwise the subscription call is put through as soon as possible after the specified time on the first circuit to become available.

The subscription call connection will be broken down as soon as the caller indicates that the conversation is finished, even before the expiration of the contract period. At the expiration of the contract period the connection will be broken down if the caller has not requested an extension of time. If the caller requests an extension this may be granted up to 12 minutes in all, or six minutes if a superior class of call is waiting or if the network is very busy or suffering from a break-down.

(*) From.....o'clock to.....o'clock.

(†) From.....o'clock to.....o'clock.

(‡) Fill in or strike out as required, the words in brackets.

The extension of time is charged per minute at the rate applicable to subscription calls for that particular period.

ART. VII.—No compensation should be given and no refund made if, by the act of the subscribers, the call has not taken place or has not had its prescribed duration.

A subscription call which for some reason attributable to the telephone service has not taken place or has not had its full duration of time, is, if possible, replaced or compensated for, by a call of equal length to the unexpired portion of the time, and before the end of the same charge period. If it cannot be replaced or compensated for in the same charge period, only the charge for the time actually used shall be entered on the accounts. If this time does not amount to three minutes, no charge is made. To calculate this period the charge for the complete subscription call period is taken as a base, and this basic charge is considered as equal to 1/25 or 1/30 of the total monthly charge for the subscription, depending upon the month.

ART. VIII.—The subscriber who has arranged for a subscription call contract, may, as an exception and by making a written request 24 hours in advance, hold his conversation with a station or from a station other than those specified in the contract but being in the same exchange area.

PAGE 577.

In the section entitled " Recommendation No. 18. 1. Calls with Avis d'appel and calls with Préavis," *(beginning on p.* 575), *amend* § 5 *as follows :—*

§ 5. If, after calling at the public call office, the called party (or his substitute) makes known that he can await the call no longer, the calling party is advised and the demand for the call is cancelled.

In " § 6." *omit the words in brackets "* (warning call)."

PAGE 577.

Under " 2. Calls with Préavis," *amend "* § 1 " *as follows :—*

(1) A préavis contains only the following details :—

(*a*) Name of caller and, if necessary, his telephone number.

(*b*) A sufficient designation of the called party, that is of the specific person desired, or of the telephone station (main or extension) desired. The caller may indicate a second station of the same local exchange area or another person (substitute) at the first or second station if the specific person desired has not been found at the first station. The caller has also the facility of announcing that he wishes to speak with the person specified in the presence of an interpreter or simply with a person speaking a certain language.

(*c*) The time after which the call should be cancelled, or the period in which the call should not be established.

PAGE 578.

Amend as follows paragraph " (2) This information . . ." *commending on the 3rd line of the page :—*

(2) In principle, this information is transmitted as quickly as possible to the exchange of destination and is announced by the word "préavis," the caller's name and telephone number (or either) only being transmitted at the caller's expressed desire. Nevertheless, in international connections, where the demand for calls is met with a very short delay, the terminal stations concerned may decide that préavis calls should be classed as ordinary calls and it is only when the turn of the call materialises that the préavis information is transmitted to the far end terminal exchange.

Amend "§ 3" (17th line of page), paragraphs "(a)" and "(b)" as follows :—

§ 3. To establish a call with préavis, the procedure is as follows :—

(*a*) When the probable delay on the international circuit or circuits concerned exceeds halt an hour, the controlling operator, when transmitting the préavis to the terminal exchange, must indicate the probable delay.

(*b*) The receiving terminal exchange ascertains from the station or stations concerned, if the called party will be ready to take the call at the approximate time from which the call could be established.

Amend the last paragraph of "§ 3 (d)" as follows :—

If the terminal exchange at the called end is informed that the person called cannot or will not take the call, the caller is advised as soon as possible. The caller may then (if he has not already done so) either ask for another number or another person, or for a call to the number indicated in spite of the absence of the called person. If he does not make use of this facility, the call is cancelled.

PAGE 579.

Amend "§ 4" as follows :—

§ 4. In case of non-reply from the station called for the transmission of the préavis, a fresh call is made a few minutes later ; if there is still no reply a third call is made half an hour later. If no reply is obtained to this the caller is notified. Should he still desire to make the call the validity of the préavis is prolonged by 24 hours. During this time the called subscriber's exchange makes several attempts to call him. When a reply is obtained, the preceding rules are applied to the call.

Replace "§ 5" by the following :—

§ 5. At the warning call, the operator at the called person's end rings the station asked for, ascertains that the person called is ready to take the call, and sets up the call in the ordinary manner.

If the preavis specifies that an interpreter should be present with the called person during the call, this information is passed to the called person and no attempt is made to set up the call until information is received from the station called that this condition has been fulfilled.

If, when the call is being set up, the called station reports that it is prevented from taking the call because the called person is not available for the time being, the caller is informed that his request for the call can hold good during the validity of the préavis, as given in paragraph 4 if he wishes, should he not wish to accept the call in spite of the absence of the person called ; should he decline, the request for the call is cancelled and the préavis charge only is made.

If the préavis has been transmitted at the same time as the call, the caller is advised, at the end of one minute, that the called party cannot be found immediately and that he will be called later.

A new attempt is made under the foregoing conditions as soon as the called person is ready to reply to the call.

If the called station states that the called person cannot be reached, the caller is advised, the caller's exchange gives the number of the telephone station or the name of the called person's substitute ; an attempt to establish the call is made later.

Replace "§ 6" by the following :—

§ 6. (1) The chargeable period for a préavis call commences at the moment when the calling station is put in communication with the person called, this period, however, commences at the latest one minute after the moment when, communication having been established between the two stations concerned, the two stations have answered.

In addition to the charge for the call, the préavis charge is made.

(2) The préavis charge is not made under the following conditions :—

(*a*) When, due to the fault of the telephone service, the préavis has not been correctly transmitted.

(*b*) When, after reception of the préavis, the call cannot take place due to the telephone service.

If the caller cancels a call with préavis after the transmission of the préavis has commenced, the called terminal exchange is informed of the cancellation and advises the called station if the latter has received the préavis.

Replace "§ 7" by the following :—

§ 7. In case of non-reply of the calling or called subscriber, the préavis charge only is made ; this charge is made even if the préavis has not reached the called station because the latter has not replied [Paragraph 200 of the RTf (Article 31, Paragraph 7) which provides for this constitutes an optional regulation].

PAGE 581.

In the section entitled "Recommendation No. 19. Bourse Calls," commencing on page 580, *amend "§ 4 (1)" to read as follows :—*

§ 4. (1) The charge for a Bourse call is similar to that for a call of similar category and duration. This charge commences the moment that the call is given to the broker.

However, if the preceding call has lasted less than three minutes and if the broker is not present to take his call at the expiration of these three minutes, the charge only begins at the end of these three minutes.

Amend "§ 5" to read as follows :—

§ 5. When a call is refused by the caller or the called broker, a charge is made equal to that for one minute of ordinary call between the calling station and the Bourse exchange during the period at which the refusal occurred.

PAGE 582.

In the section entitled "Recommendation No. 20. Calls Paid by the Person Called," commencing on page 581, *replace the text after "Unanimously recommends" by the following :—*

That calls paid by the persons called should be admitted by agreement between the Administrations and Operating Companies concerned and may also be associated with a préavis or an avis d'appel.

These calls should carry a surtax equal to that for calls with préavis (cost of one minute's conversation at the same charging period).

No surtax, however, is charged other than for a préavis or avis d'appel in the case of a call paid for by the person called and which makes use of a préavis or an avis d'appel.

If the person called agrees to pay for the call, he must pay in addition to the charge for the call, a surtax equal to one minute's conversation.

The call is considered as having emanated from the receiving exchange and the accounting is done by this exchange in place of the exchange actually originating the call.

If a call payable by the person called is made when the charging period (heavy or light traffic) is different in the country of origin and in the country of destination the charge must be calculated by using the tariff in force in the country in which the payer of the charge is located at the legal time for that country at which the call has been made.

If the call has not been completed the surtax is calculated on the tariff in force in the country of origin at the legal time when the request for the call has been made.

If the person called refuses to pay for the call, a surtax equal to the charge for one minute's conversation is charged to the caller at the originating exchange ; in the case of a call payable by the person called which is combined with a préavis or avis d'appel the caller is only charged the surtax applicable to a préavis or avis d'appel should the person called refuse the call, the caller abandoning the call.

PAGE 584.

In the section entitled " Recommendation No. 22. Leasing International lines, not comprising Submarine Sections, for Private Purposes," *commencing on page* 583, *amend "* Part II. Rates *" to read as follows :—*

Unanimously recommends :—

That the charge for the hire of an international line should be determined in each case by agreement between the Administrations and Operating Companies concerned, but that the maximum charge should be based on 80 units of charge per day for the same connection, assuming 300 days per year.

That in every case, even for frontier connections, the receipts should be included in the international accounts.

PAGE 587.

In the section entitled " Recommendation No. 29. Assignment of the Serial Number to a Call," *amend paragraph "* (1) *" to read as follows :—*

Unanimously recommends :—

That, by agreement between the Administrations and Operating Companies concerned, a serial number can be assigned to each request for a call by the terminal exchange at the originating end at the moment the request is passed to the incoming terminal exchange.

PAGE 594.

In the section entitled " Recommendation No. 36. Operating Rules for International Transit Traffic *" (commencing on p.* 593), *paragraphs "* d *" and "* e *" are now combined as paragraph d, Paragraphs "f," "g" and "h" now become paragraphs e, f and g, respectively.*

PAGE 599.

In the section entitled " Recommendation No. 43. International Telephone Charges *" (Commencing on p.* 598), *amend section "* II *" to read as follows :—*

II. GUIDING PRINCIPLES FOR CALCULATING INTERNATIONAL TELEPHONE RATES.

Following the study of the cost price of international telephone calls not using a long distance international radio link, made in 1935, the C.C.I.F. are of opinion that in general* the cost price of the call is covered by the following items :—

* The calculation of cost price made by the C.C.I.F. in 1935 was made on the following basis :—
  — Average traffic per international circuit : 200 chargeable minutes per day and 300 days per year.
  — Proportion of reserve international telephone circuits in submarine cables : Average 40 per cent. (say 60 per cent. circuits in service and 40 per cent. in reserve).
  — Interest on borrowed capital : 6 per cent.
  — Average life of a submarine cable : 35 years.
  — Percentage difference between actual length and crowfly length of circuit : 30 per cent.

A. Frontier Connections.

Maximum charge for three minutes' call over frontier lines.

0.6 gold franc for crowfly distance between exchanges of less than 25 km.
1.0 gold franc for crowfly distances between 25 km and 30 km.

B. Other Connections.

Cost of depreciation, interest on capital, and maintenance of the circuit (excluding all internal toll circuit used in connecting the international terminal exchange to the toll exchange to which the subscriber belongs).

0.60 gold franc per three-minute conversation per 100 km crowfly distance (any fraction below 50 km being counted as 50 km and any fraction over 50 km being counted as 100 km).

Note.—The study made in 1935 has shown that in short distance connections (up to about 300 km) over which the traffic is accommodated by direct circuits, the portion of the cost price for the international circuit is considerably less than 0.60 gold franc.

Operating cost of an international terminal exchange :—

0.60 gold franc for a three-minute call (whether it is a question of a terminal exchange or a transit exchange).

PAGE 603.

In the section entitled " Recommendation No. 50. Radio Broadcast Transmissions. 1. Conditions of Admission," *amend the paragraph commencing on last line of page, "* The demands for circuits. . . ." *to read :—*

The requests for circuits for broadcast transmissions should always be submitted as soon as possible and in all cases in sufficient time for the Administrations and Operating Companies concerned to take the necessary steps to organise the broadcast transmission concerned. The requests will be satisfied if no inconvenience to the general telephone service will be caused and if technical conditions permit.

PAGE 604.

Substitute the following for the 6th, 7th, 8th and 9th paragraphs (commencing " The Central Departments . . .") :—

The Central Departments should appoint an " Official Director " for this transmission.

The Official Director advises as soon as possible each of the Central Departments interested which circuits are to be used, and should indicate the special repeater stations with which the Broadcasting Organisations may get in touch if, during the transmission, there should arise any unforeseen incident which requires immediate attention.

As soon as the Broadcasting Organisation controlling one or more broadcast stations taking the programme, receives the necessary information concerning the circuits for which it has to pay, it

should send to the Central Department of its country without delay an agreement to pay the required charge for the use of the circuits.

PAGE 605.

Substitute for the paragraph " The increase of 25% . . ." at the bottom of the page, the following :—

The above rates include the expense of adding any special apparatus to the international circuits or of modifying any regulating devices which exist on the circuit.

On the other hand, they do not include the cost of possible telegrams between the Central Departments for the organising of the programme transmission. The Administrations and Operating Companies concerned, therefore, are authorised to claim payment for these possible supplementary expenses.

Add a new paragraph to the footnote on page 605 *as follows :—*

In order to determine the heavy or light traffic periods the legal time of the country receiving the programme transmission is taken as a basis.

PAGE 606.

*An asterisk * should be inserted after the words " they would receive normally " in paragraph " 3."*
*Insert the following footnote corresponding to *.*

* The division of the total charge on a programme transmission should be made in the following manner :—

For a country furnishing one ordinary circuit, a " hypothetical rate " is calculated on the basis of the ordinary message rate during the rate period in question. For countries furnishing several programme circuits " hypothetical rates " are calculated according to the ordinary message rates during the heavy traffic period plus 25%.

Change the penultimate paragraph " If the transmission . . ." to read :—

If the transmission is relayed from intermediate stations to other broadcast stations, from the accounting point of view this is considered as several distinct messages : one between the originating exchange and the first intermediate broadcast station—the others between the consecutive broadcast stations or between a branching point and an intermediate broadcast station—or between the last intermediate broadcast station (or the last branching point) and the most distant broadcast station.

PAGE 607.

Amend the section following the table to read as follows :—

III. Radio-broadcast Transmissions by Subscription.

The International Telephone Consultative Committee—

Considering :—

That the prolonged and regular use of special broadcasting circuits by Broadcasting Organisations should be facilitated,

Unanimously recommends :—

That programme transmissions by subscription should be admitted on an experimental basis under the following conditions :—

The compulsory agreement made for the period of one month binds a Broadcasting Organisation

to pay during his month for at least five hours utilisation of a certain circuit specially constructed or arranged over the whole or part of its length to transmit music, whether this circuit serves for transmitting the programme or is used as a reserve circuit.

The extra charge of 25% as provided for under II is not made for subscription programme transmissions. Thus they are charged for at the ordinary rate for the heavy traffic period.

If the circuit involved is in part composed of a circuit constructed or arranged for the transmission of music and in part by an ordinary telephone circuit, the total charge is divided between the Administrations and Operating Companies concerned as in the case of an ordinary telephone call.

If the Broadcasting Organisations think it necessary for reserve circuits to be supplied, these circuits are charged for as though they were the actual circuits used for the broadcast, and for the entire period of the broadcast.

The conversation circuits are charged for at the rate of ordinary calls (see above).

PAGE 608.

Under the section headed "Model sketch of the Circuits used for a Multiple Broadcast" and after the paragraph "Since Amsterdam does not . . ." add the following :—

If, for example, the Hamburg radio broadcasting organisation agrees to pay the charge for the Brussels-Amsterdam section, since Amsterdam does not broadcast the transmission, the rates to be charged at Hamburg and at Copenhagen respectively, must be based on a transmission from Brussels to Hamburg and on another transmission from Amsterdam to Copenhagen.

If, in a similar manner, agreement should be reached beforehand by the various Broadcasting Organisations concerned, as to the payment for speech circuits and, when necessary, reserve circuits.

PAGE 623.

In the section entitled "Recommendation No. 64. Forecast of international traffic. List of circuits to be established," add the following as a 3rd paragraph after "Considering—" :—

That before constructing new cables, the existing cables should be utilised in the best possible manner, and that for this purpose it would be in the interest of every Administration and Operating Company to be regularly informed of the existing reserve telephone circuits in the cables of other Administrations and Operating Companies.

and continue as follows :—

Unanimously recommends :—

(1) That in order to facilitate an exchange of views between Administrations and Operating Companies concerning the establishment and putting into service of new international telephone circuits it will be useful to send to the C.C.I.F. Secretariat each year, on July 1st :—

(*a*) All useful documents indicating the sections of reserve four-wire circuits (having repeaters) which exist or are proposed on the main routes of the European international system.

(*b*) The list of new international circuits which Administrations and Operating Companies believe it necessary to set up.

(2) That the following form should be used to communicate this information :—

PAGE 624.
The Table has now been amended as shown :—

List of Reserve International Circuits and New International Circuits, the Provision of which is deemed necessary by :—

(Name of Administration or Operating Company).....

Communication with *	Circuit Designations.	Number of circuits in service on the route involved.	Number of repeatered 4-wire reserve circuits existing on the route considered	Number of 4-wire reserve circuits planned but not yet existing	Names of countries through which the route considered passes.	Average daily number of minutes of conversation exchanged over all the circuits on the route under consideration.						Average % increase per annum observed during the last two years.	Number of circuits proposed.			Is the Administration or Operating Company who compiled this table willing to guarantee a minimum revenue to transit countries for the projected circuits ?
1.	2.	3.	4.	5.	6.	7.						8.	9.			10.
						In 1934.		In 1935.		In 1936.			1937	1938	1939	
						From 8 a.m. to 7 p.m.	From 7 p.m. to 8 a.m.	From 8 a.m. to 7 p.m.	From 7 p.m. to 8 a.m.	From 8 a.m. to 7 p.m.	From 7 p.m. to 8 a.m.					

* Give the names of the countries in alphabetical order.

PART IV.

NOTE.—From here to the end of this volume all text is new and does not appear in any form in the 1934 English edition.

LIST OF QUESTIONS SET FOR STUDY BY THE XIth PLENARY MEETING

(Copenhagen 11th–20th June, 1936.

In the following list of questions the number of the C.R. to which the study of the question has been allotted has been shown and also when necessary the collaborating C.R.'s. The category into which the question falls has also been shown as follows :—

Category A.1. Questions to be discussed orally and for which international agreement covering the whole world is necessary.

Category A.2. Questions to be discussed orally and for which an international agreement covering Europe only is necessary.

Category B. Questions having only a documentary nature to be treated in writing.

The different lists which follow are called respectively :—

1. Questions of protection against interference of which the study is to be undertaken or continued by the 1st C.R. in 1937 and 1938.
2. Questions of protection against corrosion of which the study is to be undertaken or continued by the 2nd C.R. in 1937 and 1938.
3. Questions of transmission and maintenance of which the study is to be undertaken or continued by the 3rd, 4th and 5th C.R.'s and by the Mixed Committee for the European General Toll Plan in 1937 and 1938.
4. Questions of operation and traffic of which the study is to be undertaken or continued by the 6th and 7th C.R.'s in 1936 and 1937 and by the Mixed Committee for the European General Toll Plan in 1937 and 1938.

1. List of questions concerning protection against interference, the study of which is entrusted to the 1st C.R. in 1937 and 1938.

Question No. 1 (Category A2).

(*a*) Study of the equivalent disturbing voltage and, if necessary, the equivalent disturbing current of alternating or direct current power and traction installations.

(*b*) Normal limiting values of the telephone form factor of voltages to be observed in the construction of various types of machinery and equipment.

Note.—The present position of this question is given below.

Annex.

Measurements of the equivalent disturbing voltage and the equivalent disturbing current have been made in several countries by means of noise meters constructed to the specification drawn up at Budapest in 1934. But the results obtained up to the present are not sufficiently numerous to allow of the deduction of representative average figures for these two values. It has been considered advisable, however, to quote some of the results obtained so as to give an idea of the values to be expected for various kinds of power and traction systems.

The results given below should therefore only be considered as indicative and not as definite values. Some of these results are mentioned in the Compte-rendu of the 4th Plenary Meeting of the

C.M.I., and the information concerning these has been amplified by a few values measured on rectifiers, in order to show how the equivalent disturbing voltage varies with the load and, where triode rectifiers are concerned, with the load factor.

The various measurements have been obtained both with and without the insertion between the noise meter and the power installation being studied of an arrangement resulting in the multiplication of the relative amplitude of each harmonic by the corresponding frequency. In the first case the final value of the test is followed by the sign xf and in the second by the sign xl (multiplied by 1).

TABLE SHOWING RESULTS OF MEASUREMENTS OF THE EQUIVALENT DISTURBING VOLTAGE OF VARIOUS POWER INSTALLATIONS.

I. Diode Rectifiers.

(1) Six-phase rectifiers — 2 to 4.5% (xl)

(2) Twelve-phase rectifiers — 1 to 1.5% (xl); 0.9 to 2.2% (xf)

II. Triodes used as rectifiers.

(1) Six-phase rectifiers

Load factor: 1.0 — Up to 3.3% (xl); Up to 3 % (xf)

Load factor: 0.8 — Up to 12 % (xl); Up to 11 % (xf)

Results of routine tests made on apparatus in service :—

(*a*) A 75 kW (750 V, 100 A) Rectifier.

Load Factor	Telephone form factor of voltage.	
	At full load.	At 1/3rd load.
1.0	2.7% (xl)	2.8% (xl)
0.9	3.7% (xl)	7.3% (xl)
0.8	4.8% (xl)	9.1% (xl)

(*b*) A 220 kW (440 V, 500 A) Rectifier.

Load factor	Telephone form factor of voltage.	
	At 3/4 full load.	At 1/4th load.
1.0	3.1% (xl)	2.6% (xl)
0.9	6.9% (xl)	9.5% (xl)
0.8	9.3% (xl)	12.1% (xl)

(2) Twelve-phase rectifiers.

Load factor: 1.0 — Up to 2 % (xl); Up to 2.4% (xf)

Load factor: 0.9 — Up to 5.5% (xl)

III. Single phase lines (Trolley wire of alternating current railways).

(1) Measurements in a substation.

0.1 to 0.25% (xf)

(2) Measurements on the trolley wire.

0.14 to 1.4% (xl)

0.66 to 1.5% (xf)

IV. Three phase networks (Measurement between two phases).

(1) Cable network.

(*a*) 5 kV—Load : six-phase rectifier.

0.5 to 3.8% (xf)

(*b*) 6 kV—

0.4 to 0.7% (xl)

0.1 to 0.3% (xf)

(*c*) 10 kV—Load : twelve-phase rectifier.

1.0 to 1.65% (xl)

1.1 to 2.1 % (xf)

(2) Overhead network (open-wire)

(*a*) 10 kV—

0.45 to 0.95% (xl)
0.2 to 0.8 % (xl)

(*b*) 20 kV—

0.25 to 0.72% (xl)
0.10 to 0.51% (xf)

(*c*) 50 kV—

0.38 to 0.65% (xl)
0.14 to 0.27% (xf)

(*d*) 100 kV—without rectifier load.

0.4 to 0.55% (xl)
0.12 to 0.22% (xf)

with rectifier load.

Up to 1.8% (xf)

Question No. 2 (Category A2).

What is the value of psophometric E.M.F. produced by power lines which may be considered as admissible in the various cases of telephone circuits ?

Note.—For the solution of this question, the 1st C.R. will be guided by the answers made by the other competent C.R.'s to the following questionnaire.

1. In the case of non-repeatered open-wire circuits what value can be considered as admissible for the psophometric E.M.F. at the end of the open-wire toll line, that is to say, at its entrance to the exchange, all internal exchange wiring being disconnected at the point where the measurement is made ? The line must be closed by 600 ohms, if necessary using an inequality ratio transformer (see Vol. II Protection-Recommendation No. 4—II Method of use. (English Edition, 1934, p. 118)). In this connection the most unfavourable condition that the telephone service encounters in practice, is simulated.

2. In the case of a cable circuit what value can be considered as admissible for the psophometric E.M.F., under the most unfavourable transmission conditions met with in practice, measured at the end of the toll cable circuit, all repeaters and internal wiring, etc., being disconnected at the point where the measurement is made ? The line must be closed by 600 ohms, if necessary using an inequality ratio transformer (see Vol. II Protection-Recommendation No. 4—II Method of use (English Edition, 1934, p. 118)).

In any case, in view of the problem to be solved by the 1st C.R. it must be understood that the values of psophometric E.M.F. to be given to the 1st C.R. will refer solely to the noise due to the electromagnetic influence of the power lines excluding any other cause of noise.

Annex to Question 2.

Tests have been made in the SFERT laboratory in order to determine the reduction in articulation due to the presence of a psophometric E.M.F. on the telephone line.

The programme of these tests was drawn up in full agreement with the telephone authorities, and its main lines were examined by the C.M.I.

Among the results obtained, those which should first be considered are those resulting from tests carried out using a reference equivalent of 40 decibels which corresponds especially to a long distance connection between two subscribers, partly in cable and partly in open-wire line of medium length, when the overall attenuation of the lines is about 28 decibels (3.2 nepers).

The schematic of the test arrangement which was developed in 1935 is shown on page 9 of the

document " Programme of the tests to be made by the SFERT Laboratory from Oct., 1935, to Feb., 1936, relative to the effect of circuit noise."

This schematic is that of a test circuit which reproduces the conditions of normal connections as nearly as possible.

In addition to the development of this test circuit which permits the making of measurements at all interesting points (ends of the line, terminals of the subscriber's instrument, receiver terminals) development has also been carried out between times of psophometers having the curve definitely established in 1934 and the use of which in each practical application has been fixed.

Finally, the technique of the tests bearing on the measurement of the reduction of articulation has been improved little by little in the course of the last few years ; the tests mentioned having been made in accordance with the methods which are recognised as being the surest (alternate tests).

The following table gives the principal results obtained in the course of the last series of these tests. These were made in the presence of a room-noise of 45 decibels above the threshold of audibility.

Psophometric E.M.F.	5 mV	10 mV
Description of noise	Reduction in articulation (1)	
6-phase rectifier	7.3	13.6
Mixed frequencies (350, 450, 550, 650)	4.5	15.9
General Average	5.9	14.7

(1) **Note.**—Reduction in articulation $= \frac{n_1 - n_2}{n_1} \times 100$.
n_1 being the value of articulation when no noise is present.
n_2 being the value of articulation when line noise is present.

The figures shown in this table are the mean of the values obtained when using as a receiver German, British and French telephones, each telephone being mounted as it is in normal service conditions.

It will be noted then that to a value of 5 mV of psophometric E.M.F. a reduction in articulation of about 6% is obtained in these tests.

It should be remarked, however, that the results mentioned above were obtained from tests made outside normal conditions and they should be considered only as one of the elements in the study of the problem. Actually, to appreciate the trouble caused to telephone conversation complaints from dissatisfied subscribers must be taken into account. As to this last criterion, observations recently made by various Administrations have shown that the 5 mV provisionally admitted was in many cases too high.

It has, then, been recognised as being necessary to continue the study of the question in order to fix definitely the limit of psophometric E.M.F. admissible. If this limit has to be fixed with the knowledge at present available, the Telephone Administrations would be inclined to fix a figure of less than 5 mV.

Question No. 2 bis (Category B).

Statistics showing the number of subscriber complaints according to the value of psophometric E.M.F. induced on the circuit.

Note.—The procedure, which consists in measuring the articulation reduction on a telephone circuit as a function of the value of psophometric E.M.F. observed on the circuit, is only one means of indicating the reduction of telephone

transmission quality due to noise on the circuit. Furthermore, this procedure is only practicable in the laboratory and by means of specialised crews. There is accordingly much to be gained by completing these tests by noting, under service conditions and as precisely as possible, the harmful effects of circuit noise (see Question 2).

With this object in view a fixed value of psophometric E.M.F., consisting of a mixture of frequencies of known composition or, at least, origin, will be introduced in a telephone circuit. During a fixed period, the subscriber's remarks on the parasitic noise will be noted. The relationship between the number of conversations giving rise to unsatisfactory comments, and the total number of conversations held during the period, will then be determined.

This test will be repeated for several values of psophometric E.M.F. and will be carried out on different types of circuits and noises.

It would be good to use, as far as possible, during these tests, mixtures of frequencies which correspond to the noises observed in practice.

In recording the results the value of the psophometric E.M.F. measured at the end of the toll circuit, closed with 600 ohms, if necessary using inequality ratio transformer, should be shown.

Question No. 3 (Category A2).

Effect of various methods of grounding the neutral of alternating current power systems upon the amount of induced noise in neighbouring telephone lines (direct grounding, grounding through resistances or reactances of various values, insulating the neutral).

Note.—The more important information gained during the study of certain special cases is summarised below.

Annex.

A complete and definite answer to the question does not appear to be possible at present. Actually the problem is very complicated, and although the general principles are known, their application to each individual case leads to widely differing results. The following examples may be quoted :—

In Sweden it has been noted that several power systems fed without intermediary transformers by alternators, the neutral points of which were grounded direct, have given rise to serious noise on the neighbouring telephone lines.

In another case where the supply was obtained through a transformer, tests have been made with the following connections :—

1. Transformer star-star (with neutral point grounded direct).
2. Transformer delta-star (with neutral point grounded direct).
3. Transformer star-star or transformer delta-star (both without any grounding, or even with grounding through a high value reactance).

It was found that the psophometric E.M.F. on a neighbouring telephone line had values respectively of 10, 2 and 1.

In America studies have been made of a power system both with the neutral insulated, and with the neutral grounded, either by means of a Petersen coil, or by means of a high impedance transformer, or through resistances of various values. Under normal working conditions of the power system, it has not been possible to give a preference to any one of these practices, so far as the magnitude of the noise induced on the adjacent telephone lines was concerned. It was recognised that the Petersen coil, which was the case mainly studied, effected a rapid disappearance of the effects of accidental and temporary grounding.

The C.M.I. has examined the results of tests carried out in Great Britain on power systems having the neutral grounded direct, and has remarked as follows :—

In the course of these tests the currents in the neutral were weak. By increasing the number of grounds on the systems, no appreciable increase of induced noise in the telephone circuits has been obtained.

An unbalance of the line with regard to earth has had the principal effect of modifying the proportion of harmonics not being multiples of 3.

The use of at least one delta winding of suitable size in the various transformers of which the neutral is grounded allows the harmonic multiples of 3 to be suppressed, and reduces very considerably the interference current from the power system.

Question No. 4 (Category B).

(*a*) The bringing up to date of the table showing the arrangements used for protection in various countries, not only from the point of view of schematics, but also from the point of view of the characteristics of the various components (fuses, lightning conductor, heat coils) (see White Book 1934, Vol. II, p. 28 (English Edition p. 126), Recommendation No. 17 " Exact determination of the Principal Characteristics of Protective Devices ").

(*b*) Establishment of a protective arrangement conforming to the general conditions laid down in Recommendation No. 16. " Ideal Protective Device " (see White Book 1934, Vol. II, p. 27 (English Edition p. 126)).

(*c*) What is the best method of characterising and measuring the calorific capacity of a fuse ?

Note.—The present state of the question so far as (*b*) and (*c*) are concerned, is briefly given by the following annex.

Annex to Question No. 4.

1. The information contained in the new documents shows that it has been possible to produce a device almost fulfilling the requirements laid down in 1931 for an " ideal protective device " which would combine in the one device both the fuse and the heat coil.

The device produced is at least as satisfactory as fuses with heat coils so far as calorific capacity is concerned as well as in the force with which it operates, both in the case of a short circuit and in the case of a small current of lengthy duration.

One of the difficult points in the manufacture of an " ideal protective device " is to ensure that it will break a heavy high tension current without establishing an arc. The first model of the device mentioned above has been still further improved in this respect. Tests of this device in practice should therefore now be made.

2. The calorific capacity of a fuse has hitherto been described and measured by the number of joules it will carry without being damaged when a condenser is discharged across it. If I is the instantaneous value of the current and h the resistance of the fuse, this number of joules is given by

$$\int I^2 R dt.$$

The correctness of this definition is doubtful. In fact, given that, in practice, the value of the discharge current may depend upon other resistances in the circuit, it would seem more logical to define the calorific capacity of the fuses by the quantity $\int I^2 dt$, which they can carry without blowing.

The question of deciding which of these two definitions is the better not yet having been studied, it is necessary to measure both values in each case.

Question No. 5 (Category A2).

(*a*) Calculation of the psophometric E.M.F. due to ripples in the case of direct current distribution lines.

(*b*) Arrangements and precautions to be taken in the case of parallelism between telephone lines and direct current traction or distribution lines.

Note.—The present position of the question, as concerns part (*b*) is briefly summarised below.

Annex.

Various methods exist, according to the different cases which are met with in practice, for reducing voltage ripples of power systems. These methods, which consist of inductance coils in series, of oscillating circuits in series or of resonant circuits or condensers shunted across the line (these devices being used singly or in combination with one another), are of considerable assistance where the direct current systems are fed through rectifiers, since these apparatus have high values of telephone form factor of voltage. Among the best results hitherto obtained may be mentioned the following :—

The British Post Office states that tests have been made (with the factor 1) on two diode rectifiers of 200 kW and 575 V which, furnished with 4 resonant shunts, fed an electric traction system. Values of 2 volts and 1.2 volt respectively have been obtained for the equivalent disturbing voltage.

The German Telephone Administration mentions that in the case of a nominal 750 V rectifier of the Reichpostzentralamt it has been found possible to obtain a considerable reduction in the telephone form factor of the voltage by means of a suitable device for the absorption of the harmonics. This device consisted of an inductance coil and 4 resonant circuits. For a load factor varying from 1 to 0.8 it was always possible to reduce the telephone form factor of the voltage in the ratio of 35 to 1.

In another case where the German Administration has participated in tests of this kind on a variable grid rectifier which was in service (nominal voltage of 440 V), it was noted that this same factor could always be reduced by means of an appropriate absorption device by the ratio of at least 27 to 1. This device consisted of a choke coil, and a 300 p : s resonant circuit shunted by a capacity of 800 μF.

It should be remarked, however, that the results obtained in the way of reduction of equivalent disturbing voltage do not depend solely on the specification for the device reducing the harmonics, but also upon the nature of the primary supply system (balance, wave-form and frequency variation).

Question No. 6 (Category A2).

Study of the characteristics of devices for protection from acoustic shock based on the utilisation of rectifying elements, of variable resistance elements and of lightning protectors associated with a voltage transformer.

Note.—The present position of this question is summarised below.

Annex.

In accordance with Recommendation No. 12 (Protection) of the Xth A.P. study has been specially devoted to devices with rectifying elements, and to devices including a lightning protector associated with a voltage transformer.

A device incorporating a copper-oxide rectifier, the Varistor No. 3A, which functions without any polarising voltage, is in use in the United States. In the new documentation, indications of the resistance of this device as a function of the voltage applied and of the reduction of acoustic shock and attenuation of vocal currents due to the insertion of this device, are given.

Results have also been received of fresh measurements concerning the Siemens protective device, which consists of a lightning protector and a voltage transformer connected in a special (bridge) manner so as to avoid the unfavourable effect produced by the impedance of the transformer.

These two devices enable a protective effect to be obtained which is very nearly as good as that obtained from a coherer protector, and they require little maintenance. It seems likely, therefore, that the coherer protector, of which the maintenance is very difficult, may be replaced by one of these, subject to its operation being absolutely sure. It is therefore necessary to obtain experience of them in practice, in order to ascertain the most suitable conditions under which to use them, and to note whether they function with the certainty which is indispensable.

Also, it has been suggested that a protective device might be constructed upon a new principle based on the use of plates whose resistance depends upon the voltage applied. It would appear that the employment of this principle would tend to produce apparatus slightly less efficient, but occupying very much less space.

Question No. 7 (Category A2).

Statistical study of the values of the sensitivity coefficient of existing long distance circuits.

Annex.

Systematic tests have recently been carried out by the German and French Telephone Administrations.

The German tests were made on a line of some 58 km in length with at one end a 10.6 km section of loaded cable followed by an 8.4 km section of open-wire and then a further section of cable of about 2.1 km. To create the induction the cable sheath for 500 metres was used as one conductor of the disturbing current circuit, the return being by means of an auxiliary conductor independent of the cable.

The French tests were made on an open-wire line of approximately 75 km. To create the induction, either a group of wires on the same pole route was connected to the disturbing current source or this connection was made to a telegraph wire of the same length as the open-wire route, but placed some distance away from it.

In the German tests it was found that the ratio $\frac{e}{E}$ of the E.M.F. measured between the ends of the circuit to the induced longitudinal E.M.F. appeared almost independent of the position of the section of line submitted to the induction, and up to a certain point of the frequency (the frequencies used in the test were 300, 600, 800 and 1 432 p : s.) taking the various values of $\frac{e}{E}$ which were not exceeded by 80% of the cases it was found that the average value was 25 millivolts per volt.

In the French tests the average for $\frac{e}{E}$ was :—

At	300 p : s	0.9 mV/V
	800 p : s	1.5 mV/V
	1 600 p : s	3.5 mV/V

The 7th Comité d'Etudes of the C.M.I. has described in an appendix to its report at the 4th Plenary Meeting (see the compte-rendu of the C.M.I., p. 26) the conditions under which these tests were made.

Question No. 8 (Category A2).

The electrical industry foresees the realisation in the future of long power distribution lines, using very high tension current resulting from rectifying alternating current. The grounding of the neutral point and even the use of a single wire system with ground return is foreseen. Under these conditions serious interference to telephone lines can be expected resulting from (1) Use of triode rectifiers, (2) Grounding of the neutral or the use of a ground return.

With regard to disturbance to telephone lines the use of the ground as a return now being seriously considered appears particularly undesirable.

What should be the conditions of parallelism under which the coexistence of telephone and these power lines could be admitted ?

Annex.

This question has arisen in order that it may be possible to fix, before the establishment of

continuous current high tension lines, the conditions governing the coexistence of these power lines and telephone lines.

No solution of this problem can be based upon studies actually made on power lines of this nature since they do not yet exist, and it is only possible to make use of extrapolation on the results of other experiences.

Replies received on this subject are, therefore, essentially of a theoretical nature. Mention is made of certain national regulations which do not allow of the ground being used as a return conductor.

The Swedish Telephone Administration is of opinion that the use of two metallic conductors is essential and that it might even be necessary to transpose the high tension line. The German Administration gives more detailed information including figures which are taken in part from Report No. 333, presented at the C.I.G.R.E. in 1935. The construction of a very high tension continuous current line (500 kV for instance) presents two important characteristics from the point of view of coexistence with telephone lines : the almost inevitable use of rectifiers as a source of so-called continuous current and the use of the ground as a return conductor (a use which is foreseen in some publications).

Each of these would alone be sufficient to cause serious interference ; the two together would render the coexistence of open-wire telephone lines with power lines of this nature, almost impossible. To understand this it must be remembered that the power line current is produced not only by the continuous voltage of 500 kV but also, for instance, by the combination of one alternating voltage of 300 p : s and 30 000 V, of another of 600 p : s and 6 000 V, of voltages of 900 at 1 200 p : s, of 3 500 V, etc. The equivalent disturbing voltage, therefore, would be equal to 15 000 V and the equivalent disturbing current to 30 A (assuming the impedance characteristic equal to 500 ohms). The preceding figures refer to a six-phase diode rectifier. If this rectifier was of triode type the amplitude of the harmonics would be greatly increased. It is sufficient to compare these figures with those of the equivalent disturbing voltage of a three-phase 220 kV line, which is sometimes over 1 000 V, to see that a two-wire continuous current line (supplied by rectifiers) can cause serious disturbance, and that a line of this nature using a ground return would render impossible the operation of an open-wire telephone line of any length within a distance of several tens of kilometres.

The most suitable method of rendering coexistence possible obviously consists in using two conductors for the power line and, when necessary, transposing them. This would also obviate any danger of corrosion of underground metallic structures, since there would be no continuous current passing through the ground. It may be that earthing the neutral of a two-wire continuous current line may be necessary to permit taking most advantage of the insulation of the conductors. Generally speaking, this earthing of the neutral would have no reaction upon the operation of the telephone lines provided that the voltage of the two conductors is perfectly symmetrical with regard to the neutral.

If, on the other hand, as a result of any technical or economic conditions the use of the ground as a return conductor is proposed, the question would arise as to what arrangements should be made with regard to the high tension line so that this line should not cause more interference than a three-phase line of similar power. These arrangements should result in a reduction in interference in the order of about 100 to 1.

Doubtless a very considerable reduction could be obtained by fitting a device very efficient in the reduction of harmonics to a rectifier having a very large number of phases (consisting, for instance, in connecting in series several rectifiers whose supply voltages would all be out of phase with one another). A still better method would be to use a cable for the high tension line, so as to take advantage of the screening effect of the sheath current. These procedures, however, are only palliatives and cannot replace completely the use of a two-wire line.

With regard to the risk of electrolytic corrosion of buried metallic structures, this risk seems to be serious in the neighbourhood of earthing points of continuous current transport systems when there are one-wire systems, since then the earthing points drain a heavy current. It would therefore be necessary to prohibit in principle the presence of any cable or metallic conduit forming part of a network for a considerable distance round each earthing point, say 3 kilometres.

Cables and ducts which it is absolutely necessary to install in this area should have a sufficient number of insulating joints provided, and be separated from their networks by the same means.

It may still be asked whether the risk of serious corrosion will not be encountered throughout a strip of land on each side of the transport line.

It may once more be stated that the foregoing information is obviously subject to revision since, in the absence of any actual system on which tests could be made, it was based upon theoretical considerations only ; nevertheless, these considerations are sufficiently strong to indicate the necessity for making the strictest reservations with regard to the operating of telephone systems when transport lines of very high tension continuous current are constructed with one wire and earth return.

2. List of the questions of protection against corrosion and of the questions concerning the constitution of cable sheaths the study of which is entrusted to the 2nd C.R. in 1937 and 1938.

Question No. 1 (Category B). (Sequel to the Question No. 1 studied in 1935/1936.)

The possibility of substituting for lead, either entirely or partially, certain organic materials (for instance, derivatives of cellulose, india-rubber, etc.).

Note.—The present position as regards this question is briefly summed up below.

Annex.

Various attempts have been made to substitute organic substances (for instance, derivatives of cellulose, india-rubber, etc.) for the lead sheaths of cables.

It has also been suggested, especially for the elimination of osmosis, that the lead should only be partially replaced by one of these organic substances, the sheath thus consisting of the organic substance overlaid with a film of lead.

The research carried out has been directed towards finding a substance, which by itself or in association, would enable a sheath to be obtained sufficiently strong, very resistant to chemical action, proof against water and impervious to humidity when surrounding a more or less hygroscopic core. These qualities should be lasting, and, especially, should be maintained in spite of severe changes in temperature.

It appears that up to the present this research has not led to any complete or definite result ; nevertheless, the manufacturers are of opinion that the partial results obtained are encouraging.

It should be noted that the mechanical strength of a cable having such a sheath could be increased by means of a suitable armouring which would also have the effect or strengthening its protection against chemical reactions from the soil.

When it is necessary for the cable sheath to have a certain conductivity to compensate for the inductive effects of neighbouring power lines, and to provide protection in the case of lightning, this could be obtained by incorporating a suitable number of copper strands in the covering to the cable.

It cannot yet be foreseen what exactly will be the cost of this kind of sheath, but it is thought that this would not be of such magnitude as to discourage any continuation of the study.

Question No. 2 (Category A2). (Sequel to the question 4b. studied in 1935/1936.)

(*a*) Revision of the suggested recommendations for the protection of cables against chemical corrosion.

(*b*) Action of cements and mortars of various kinds on cable sheaths.

(*c*) Specification for cable sheaths ensuring protection from chemical or electrolytic corrosion—chemical treatment of cable sheaths to increase their resistance to chemical corrosion—possibility of using semi-conductive coatings to increase the resistance of sheaths to electrolytic corrosion.

Note 1.—The study of this question will be continued by the 2nd C.R. of the C.C.I.F. in collaboration with the 25th and 27th Comités d'Etudes of the C.M.I.

Note 2.—The present position as regards this question is briefly stated below.

Annex.

α From the special viewpoint of resistance to chemical corrosion due to the soil, it does not appear possible to give any general recommendations. The reactions of the lead, or of one of its alloys, varies, though normally very slightly, according to the nature of the soil.

One precaution which might be taken, however, is to avoid, as far as possible, either by the method of laying the cable, or by the use of protective coatings or casings or of armour, that the sheaths are in direct contact with water or with the soil when there is a possibility of reaction setting up.

The question of protection of cable sheath against chemical action also occurs when cables are placed in ducts of various cement or mortar constitution. It is of considerable interest that this question should be investigated and that the remarks of the Administrations and Operating Companies on this subject should be obtained.

β Save in certain special cases of cables, or sections of cable specially exposed to electrolytic corrosion as a result of the route followed, excellent protection has always been afforded under the following conditions :—

The cable is provided with a compact covering mainly consisting of one or more layers of textile material (jute, hemp, etc.) thoroughly impregnated with a neutral composition having a base either of oil-tar (of suitable specification) or asphalte, or of a derivative of petrol distillation. This covering is also so constructed that it remains intact once the cable is placed and remains sheltered from humidity.

Protection is obtained from this covering either by the method of installing the cable (placing, without pulling, in subways or smooth conduits kept as dry as possible) or through its own construction (steel tape or iron wire armour completely surrounding the impregnated textile material around the sheath, the armour itself being overlaid with an impregnated textile covering).

A practice which may be recommended would appear to be to cover the sheath with one or two layers of impregnated paper tape under the first layer of impregnated textile material.

As regards the impregnating substance, the use of bituminous material or of derivatives of petrol distillation has not given rise to any objection.

Derivatives obtained from the distillation of oil must not contain any free anthracene or any phenols or acids soluble in water, otherwise they may attack the lead. With this exception they may be used satisfactorily as is shown by the long experience of Telephone Administrations and numerous power distributing companies using armoured cable.

The question of a specification to be recommended for impregnating compound and especially the chief chemical tests for proving them exempt from harmful constituents (phenols, acids, etc.) has been investigated for several years by some of the international organisations of the electrical industry

but is not yet decided upon. It appears, therefore, that the C.C.I.F. should also investigate by arranging for collaboration with the power authorities through the C.M.I.

Information is also lacking for the specification for the various materials to be used in the manufacture of the coverings to render them plastic, waterproof, etc., and for the most suitable methods of application.

When it has been necessary to obtain a much more complete protection of cables certain methods, effective but costly, have been used, such as placing a sheath of vulcanised india-rubber or one having a base of india-rubber over the lead sheath. Some of these compositions maintain their insulating properties for a long time and are also strong enough mechanically to withstand any damage occurring during the placing of the cable. An even better protection has been obtained by using two lead sheaths separated from one another by a layer of vulcanised india-rubber, the continuity of the outer lead sheath being broken at regular distances and thus providing insulated joints.

Research has shown that chemical treatment of the sheath before being covered, can increase its resistance to chemical corrosion.

Further studies are in hand to see if semi-conducting coatings, proof against chemical action, applied to the sheath before it is covered would not increase its resistance to electrolytic corrosion.

Question No. 3 (Category B). (Sequel to question No. 4A-a studied in 1935/1936.)

Resistance to intercrystalline disintegration of lead alloy sheaths.

Note.—The present position with regard to this question is briefly stated below.

Annex.

The expression " intercrystalline corrosion " being hardly correct, has been gradually dropped by the technical experts who had previously made use of it in favour of " intercrystalline disintegration."

Everywhere efforts are being made to find lead alloys having great resistance to " intercrystalline disintegration " when submitted to alternating stresses.

Among the alloys already in use for cable sheaths mention may be made of lead with 3, 2 or 1% tin, lead with 0.95% antimony, a ternary alloy with 1% antimony and 0.06% copper, and lastly, of ternary alloys using tin and cadmium or antimony and cadmium.

It does not appear possible to classify these alloys according to their resistance to intercrystalline disintegration because the tests with regard to this have usually been made in different laboratories and with different methods.

Nevertheless, it would appear from the results published that all these alloys are superior to pure lead from the point of view of resistance to fatigue.

Recently alloys have been found which appear to have a resistance to fatigue at least equal to, if not better than, the alloys mentioned above. These consist, for example, of alloys of lead and calcium containing from 0.03 to 0.07% of calcium and of lead and 0.06% tellurium. Studies concerning the practical application of these alloys to telephone cables are still in hand.

Question No. 4 (Category A2).

Study of new testing methods and of the improvements to the apparatus for use in the study of corrosion of underground conduit.

Revision and amplification of the corresponding appendix in the Recommendations.

Note.—The study of this question will be continued by the 2nd C.R. of the C.C.I.F. in collaboration with the Comité d'Etudes No. 23 of the C.M.I.

Question No. 5 (Category A2).

Study of the relation between the distribution of potential on the surface of the ground and the intensity of the current flowing along a buried conductor, or escaping from this conductor when the ground is very dissimilar in the neighbourhood of these conductors.

Note.—The study of this question will be continued by the 2nd C.R. of the C.C.I.F. in collaboration with the Comité d'Etudes No. 24 of the C.M.I.

Question No. 6.

Study of the effect of the normal method of constructing long pipe lines or networks of pipe lines, on the size of the stray currents between these pipe lines and the soil.

Note.—The study of this question will be continued by the 2nd C.R. of the C.C.I.F. in collaboration with the Comité d'Etudes No. 24 of the C.M.I.

Question No. 7 (Category A2).

(*a*) What means should be employed on railways electrified by means of continuous current, especially at bridges and tunnels, to reduce as far as possible the loss of current in the ground ?

(*b*) What precautions should be taken on electrified railways, especially at bridges and tunnels, in placing telephone cables, to avoid electrolytic corrosion ?

(*c*) In the case of a severe fault occurring, especially at a bridge or tunnel, on a railway electrified with continuous current, how are the stray currents in that neighbourhood (bridge or tunnel) distributed ?

Question No. 8 (Category B).

The electrical industry foresees the realisation in the future of long power distribution lines, using very high tension direct current. The grounding of the neutral point and even the use of a single-wire system with ground return is foreseen.

Under these conditions electrolytic corrosion of nearby telephone cables is to be feared. What should be the conditions governing the coexistence of these extra high tension direct current distribution lines with neighbouring telephone cables ?

Question No. 9 (Category A2).

Study of cathodic protection both with and without association with protective coverings.

Note.—Study of this question will be continued by the 2nd C.R. of the C.C.I.F. in collaboration with Comité d'Etudes No. 26 of the C.M.I.

3. List of transmission questions to be studied in 1937 and 1938 by the 3rd, 4th and 5th C.R.'s.

Arrangement by subject of the transmission questions to be studied in 1937 and 1938 by the 3rd, 4th and 5th C.R.'s.

Specification for systems of commercial telephone transmission.

Questions 1, 1 bis, 5, 15.

Co-ordination of telephony and radio telephony.

Questions 6, 7, 9.

Broadcast Transmission.

Questions 8, 11, 14, (part of 24).

Crosstalk.

Questions 12, 12 bis.

Circuit Noise.

Questions 2, 2 bis, 3, 3 bis, 3 ter.

Room Noise.

Questions 18, 22.

Co-existence of telephony and telegraphy.

Question 10.

Volume Measurement.

Questions 24, 27.

European Toll Telephony.

Question 4.

Ringing on Telephone Circuits.

Questions 13, 20.

Subscribers' Apparatus.

Questions 16, 17, 19, 21, 26.

Articulation and Effective Transmission Equivalent.

Questions 23, 25.

Summary of the transmission questions to be studied in 1937 and 1938 arranged according to the C.R.'s. involved.

3rd C.R.

Numbers of the transmission questions of which the study is mainly the responsibility of the 3rd C.R.:

1, 1 bis, 2, 2 bis, 3, 3 bis, 5, 8, 10, 11, 12, 12 bis, 13, 14, 15, 19, 20.

Numbers of the transmission questions in the study of which the 3rd C.R. collaborates:

3 ter, 6, 7, 9.

4th C.R.

Numbers of the transmission questions of which the study is mainly the responsibility of the 4th C.R.:

3 ter, 16, 17, 18, 21, 22, 23, 24, 25, 26, 27.

Numbers of the transmission questions in the study of which the 4th C.R. collaborates:

2, 2 bis, 3, 3 bis, 5, 11, 12 bis, 19.

5th C.R.

Numbers of the transmission questions of which the study is mainly the responsibility of the 5th C.R. :

6, 7, 9.

Numbers of the transmission questions in the study of which the 5th C.R. collaborates :

8, 11, 14, 24.

Table of Questions concerning Transmission, the study of which is to be undertaken or continued in 1937 and 1938.

Question No.	Subject	Category	C.R.'s concerned
1	Specification of carrier-on-cable systems for use on loaded cables	A2	3
1 bis	Specification of carrier-on-cable systems for use on non-loaded cables ...	A2	3
1 ter	Specification for Television Circuits ...	A2	3 UIR
2	Noise limits	A2	3, 4, 1
2 bis	Noise impairment	A1	3, 4
3	Noise impairment curve	A1	3, 4, 1
3 bis	B network for Psophometer	A1	3, 4, 1
3 ter	Use of Psophometer for measuring discontinuous noises	A1	4, 3, 1
4	General Toll Plan for Europe	A2	Mixed Committee
5	Characteristics of Echo Suppressors ...	A1	3, 4
6	Interconnection of two Radio Links by Land Line...	A1	5, 3
7	Secrecy Devices for Radio Telephone Circuits	B	5, 3
8	Control of volume variation in broadcast circuits	A2	3, 5 UIR
9	False operation of echo suppressors ...	A1	5, 3
10	Private telegraph service over subscribers' loops	A2	3, 6 CCIT
11	Modification of Psophometer weighting curve for broadcast circuits... ...	A1	3, 4, 5 UIR
12	Limits of crosstalk	A2	3
12 bis	Measurement of crosstalk	A1	3, 4
13	Near end supervision and voice frequency signalling	A2	3, 6
14	Non-linear distortion on broadcast circuits	A2	3, 5 UIR
15	Impedance of international circuits ...	A2	3
16	Message metering systems	B	4
17	Sub-set efficiency	B	4
18	Measurement of room noise ...	A1	4 CEI
19	Measurement of reference equivalent of side tone	A2	3, 4
20	Automatic ringing on International Circuits	A2	3, 6
21	Non-linear distortion in subscribers' equipment	A1	4
22	Standard room noise	A1	4
23	Effective rating	A1	4
24	Reference volume	A1	4, 5 UIR
25	Articulation rating	A1	4
26	Sub-sets with loudspeaker receivers ...	A2	4
27	Reference equivalent of subscribers' sets	A1	4

Questions Nos. 1 and 1 bis. Carrier on Cable 3rd C.R. (Category A2).

Question No. 1. Specification of Carrier on Cable Systems for Use on Loaded Cables.

(*a*) What values it is desirable to fix for the relative level at the output of intermediate repeaters for multi-channel carrier systems, especially in the case of frontier stations ?
What are the allowable tolerances for :—

(1) the departures from the nominal value of level for the average frequency of the voice channel considered ? ;

(2) for the variations in level with time ?

(*b*) What are the admissible values for near end crosstalk between the pairs or quads of a loaded cable used for :—

(1) Single-channel carrier ? ;

(2) Multi-channel carrier ?

Note.—One should consider also the question of crosstalk attenuation for the most critical frequency which is usually the highest frequency transmitted.

(*c*) What is the maximum allowable value for capacity and inductive unbalances for loaded cable pairs or quads which are to be used for multi-channel carrier ?

(*d*) What should be the maximum allowable value for harmonic distortion, for the effective resistance and the additional resistance due to hysteresis in loading coils, and for the equivalent harmonic distortion in repeaters for the case of a multi-channel carrier system ? What is the maximum allowable variation in attenuation in any channel when the input is varied from 1 to 4 milliwatts ?

Note.—Special consideration should be given to the advisability of adding, on page 196 of Vol. III of the White Book (English edition p. 263), to the section " Impedance " of the recommendation for " Repeaters for Four-Wire Circuits (Ordinary Telephony) " another paragraph as follows :—

" In the case of repeaters for extra light circuits which provide a carrier circuit in addition to the ordinary voice frequency circuit, it may be advisable to make the output impedance of the repeater small compared to the circuit impedance, so as to reduce the non-linearity effect of the repeater. In such a case the input impedance of the repeater measured under service conditions should, for all positions of the potentiometer, be such, that the reflection coefficient in the frequency band effectively transmitted will be less than, or at the highest equal to, 0.2."

(*e*) Is it desirable to foresee, in the case of a cable utilising carrier, a limit for the voice-frequency input to each voice-frequency or carrier channel ?

Note.—This limitation of input seems particularly important in the case of systems providing a large number of carrier channels.

Annex to Question No. 1.

Observations of the German Telephone Administration regarding Capacity Unbalances in Cables.

The fixing of limiting values for the capacity unbalance between cable circuits should procure the guarantee that the crosstalk between circuits can be kept sufficiently small. The maximum allowable values for capacity unbalance indicated on page 295 of Volume III of the White Book (English Edition p. 323) are not sufficiently severe to insure such a guarantee for the case of circuits used for carrier, since for the high frequencies used for carrier, there results a greater crosstalk than in the case of the frequencies encountered in the normal voice-frequency channel, with the result that the crosstalk attenuation b_n is less for the high frequencies than for the low frequencies. This may be deduced from the known relation between capacity unbalance k and crosstalk attenuation b_n :—

$$b_n = \log_e \frac{8}{\omega k \sqrt{Z_1 Z_2}}$$

where $\omega = 2\pi f$

k = capacity unbalance between two circuits,

Z_1 = characteristic impedance of the disturbing circuit.

Z_2 = characteristic impedance of the disturbed circuit.

In order to maintain, for carrier channels, the same minimum limits for crosstalk attenuation prescribed for voice frequency channels it will be necessary to establish more strict limits for capacity unbalance between circuits used for carrier than for the case of ordinary voice-frequency circuits. Since the circuits used for carrier are always 4-wire circuits it will be necessary, in fixing the maximum allowable capacity unbalance for the carrier case, to consider that the conductors used for transmission in one direction are separated from the conductors used for transmission in the opposite direction. For circuits used in opposite directions it will be necessary to fix more severe limits than in the case of circuits used in the same direction. The table given below shows the maximum allowable values for capacity unbalance for circuits used for carrier ; these values correspond to measurements made at 800 p : s on 230 metre lengths of cable.

Limiting values for 230 metre cable lengths for the capacity unbalance (in m.m.f.) between circuits used for carrier.

	Maximum Allowable Value (m.m.f.)	
Unbalance between non-contiguous circuits used for transmission in the same direction	Side to Side	30
	Side to Phantom	40
	Phantom to Phantom	60
Unbalance between circuits used for transmission in opposite direction	Side to Side	6
	Side to Phantom	10
	Phantom to Phantom	14

For circuits used for transmission in the same direction and being in the same or in contiguous quads, it is not necessary to set limits more severe than those now in force for voice-frequency operation since it will be possible during installation to reduce sufficiently the crosstalk in such cases.

Question No. 1 bis. Specification of Carrier-on-Cable Systems for Use on Non-loaded Cables.

(*a*) What are the essential characteristics (including impedance unbalances) and dielectric strength for non-loaded international circuits used for multi-channel carrier, regarding which an international agreement should be obtained ?

(*b*) What carrier frequencies should be used on such circuits ?
Should the upper or the lower side-band be transmitted ?
Should single or double modulation be employed ?

Note.—A distinction should ultimately be made between the case of balanced pairs and the case of concentric cables.

(*c*) What conditions should be imposed on such carrier systems as well as on the associated voice-frequency equipment such as repeaters, repeating coils, etc., which transmit also the carrier frequencies from the standpoint of non-linearity, especially in connection with the effects of non-linear crosstalk ?

Annex to Questions No. 1 and 1 bis.

During the discussion on this question which took place during the XIth Plenary Assembly (Copenhagen), various Administrations gave information regarding new types of cable systems whose installation had, at that time, been completed or which were foreseen for the immediate future in their respective territories.

The essential characteristics of these various systems are as follows :—

Germany.

The German Administration is using an extra-light loaded system which provides one supplementary carrier channel. The carrier frequency is 6 000 p : s, the carrier and the upper side band being

suppressed in accordance with the recommendations of the White Book (Volume III, p. 154 (English Edition p. 240)). The conductors are of 0.9 mm diameter with a cut-off of 7 700 p : s for the side circuit and 9 300 p : s for the phantoms (see White Book Volume III, p. 305, English Edition p. 329, table B). One carrier channel is added above the voice channel on each side circuit and the phantom.

Systems providing three additional carrier channels on very light loaded circuits are being tried. The conductors are of 1.4 mm diameter with a cut-off of 20 000 p : s (see White Book, Volume III, p. 305 (English Edition p. 329), table A). Phantom circuits are not utilised. Each carrier channel uses the same frequency in both directions. The carrier frequencies are 4 000, 8 000 and 12 000 respectively, and the carrier and lower side-bands are suppressed.

The German Administration is also studying a system for concentric cables. Two cables of this type (one for " go " and the other for " return ") have already been installed between Berlin and Leipzig. The attenuation for this cable is 0.16 neper per kilometre at a frequency of 1 000 000 p : s.

Repeaters are spaced at 35 km intervals and the band effectively transmitted over this cable is somewhat greater than a million cycles (that is, a band from 3 000 000 to 1 600 000 p : s with a maximum variation from the nominal value of ± 0.1 neper (the nominal value being zero). Television signals have been transmitted without distortion up to 400 km and even further.

The band effectively transmitted will, in the future, be extended to about 4 000 000 cycles with, of course, a reduction in the spacing between repeaters.

The insulation used in these cables will be either " styroflex " (Felten and Guilleaume, Siemens and Halske) or spaced insulating discs (Allgemeine Elektrizitäts Gesellschaft).

These cables have been described in the following publications :—

(*a*) K. Dohmen and H. F. Mayer—Europäischer Fernsprechdienst No. 21 for 1934, covering carrier telephony on long distance cables ;

(*b*) H. F. Mayer and F. Fischer—Elektrotechnische Zeitschrift, 1935, p. 1245—and Walter Kieser—Zeitschrift für Technische Physik, No. 12, 1935—covering concentric circuits using styroflex as insulation ;

(*c*) Europäischer Fernsprechdienst, July 1932, p. 200, under section 2, covering the concentric circuit constructed by A.E.G. and by Telefunken, and used for the interconnection of transmitting or receiving antennae in radio-telephone or radio-telegraph stations.

The German Administration is going to extend the Berlin-Leipzig coaxial cable from Leipzig to Munich and foresees the placing of two coaxial cables between Berlin and Hamburg. The Administration considers that it will be advantageous to plan for a coaxial circuit of this type in each long distance cable for meeting the demands of television or of any important growth in long distance telephone circuits.

United States.

The system actually developed in the United States secures on a non-loaded 19 B & S gauge cable pair (of the normal construction) twelve one-way carrier channels, the usual voice-frequency channel not being used. Four-wire operation is employed, separate pairs being used for each direction of transmission. In order to eliminate near end crosstalk between opposite going channels, pairs in two separate cables are used.

In this system a carrier frequency spacing of 4 000 cycles has been chosen. Crystal band-pass filters are used (see first part of C.C.I.F. Transmission Document No. 24, 1935/1936). A process of double modulation is employed at the terminals. At the sending end the 12 voice-frequency channels are stepped up to adjacent positions between 60 000 and 108 000 p : s, then the whole group is shifted

by a second modulation to the band between 12 000 and 60 000 which is used for transmissions over the line. At the receiving end the reverse procedure is followed. The carrier frequencies used after the first modulation become 64 000 to 108 000 p : s, with a spacing of 4 000 cycles since the carrier frequency used for the second modulation is 120 000 p : s. All of the carrier frequencies are generated from a common source. At each modulation the carrier and one of the side bands is suppressed.

The cable attenuation requires that the repeaters on this system be placed at approximately 17 mile intervals, or about 27 kilometres. These repeaters, which are of the negative feed-back type (see second part of C.C.I.F. Transmission Document No. 24, 1935/1936), are arranged to balance the frequency distortion of each preceding section of cable and to correct for the variations in attenuation of the cable with temperature.

Systems are being developed which use a much wider band of frequencies and which will make use of cables of special construction (such as coaxial cables and also individually screened pairs) ; one part of the study on these cables is described in an article by L. Espenschied and M. E. Strieby in Volume III of *The Bell System Technical Journal*, pp. 654 to 679, and in an article by A. B. Clark. in Volume XIV of *The Bell System Technical Journal*, pp. 1 to 7.

The American Telephone and Telegraph Company is constructing at the present time a coaxial cable between New York and Philadelphia and hopes that tests on this cable will begin in a few months.

France.

The French Administration has, at present in service, circuits with extra-light loading (22 mH on the sides and 9 mH on the phantoms, spaced every 1 830 metres) which provide one carrier channel in addition to the normal voice-frequency circuit. The carrier frequency is 6 000 p : s in accordance with the White Book regulation (Volume III, p. 154 (English Edition p. 240)). The carrier and the upper side band are suppressed. Both sides and phantoms are used.

In addition, a cable is at present being installed between Paris and Metz in which it is planned to have pairs loaded with 2.8 mH coils every 1 830 metres. Three-channel carrier systems will be used on these pairs.

Great Britain.

The British Post Office has placed in service telephone circuits providing one carrier channel in addition to the regular voice-frequency channel over cable pairs which had originally been established for telegraph circuits. A telegraph cable was rebalanced and especially loaded (to give a cut-off of approximately 8 000 p : s) and the same was done with telegraph pairs in a telephone cable. The system used provides, over a single 4-wire circuit, a carrier circuit in addition to the normal voice-frequency circuit. More than 40 circuits (of lengths from 100 miles to 400 miles) have been obtained in this way and are actually in service. This system, which transmits the lower side-band of a 6 000 cycle carrier (the carrier and upper side-band being suppressed), is used also on circuits especially planned for such use and having the following characteristics : star-quad circuits of 25 pound conductors (1.0 mm) and loaded with 22 mH coils spaced at 1.8 kilometre, giving a cut-off of 7 800 p : s The pairs used in this way are found in cables manufactured in accordance with existing C.C.I.F. specifications for ordinary voice-frequency circuits ; but tests on existing cables indicate that it will be possible to obtain in practice a limited number of pairs providing four carrier channels in addition to the normal voice-frequency channel. The pairs to be used for this five-channel system will be loaded with 6 mH coils spaced every 0.9 km.

The British Post Office is constructing a system using one cable for the circuits in one direction and another cable for the circuits in the opposite direction. Each of these cables contains 19 pairs of

1.4 mm non-loaded conductors. Repeater stations are spaced every 30 km. and the terminal equipment has been developed to provide 12 telephone channels on each pair. The carrier frequencies are spaced on 4 000 cycle intervals from 16 000 p : s to 60 000 p : s. The carrier and the upper side-band are suppressed.

In addition a coaxial cable is at present in the process of installation between London and Birmingham. It contains four coaxial circuits. The diameter of the central wire is 0.125 inch.

The internal diameter of the outer conductor is 0.45 inch. The thickness of the outer conductor, including the lead sheath with which each cylindrical conductor is covered, is 0.07 inch.

The frequency band used extends provisionally to 2 000 000 p : s. The lower limit has not as yet been set. The carrier frequencies have not as yet been fixed. The repeater station equipment has not as yet been developed.

Japan.

The Japanese Administration is convinced of the advantages which carrier on non-loaded cables present and is proposing to place within two years more than 1 500 kilometres of such cable, a part of which has already been placed and tested.

The system utilises star-quad cables (non-loaded 1.4 mm conductors) with repeaters every 60 km. Each quad gives one voice-frequency channel and six carrier channels with carrier frequencies of 7 000 p : s, 11 000 p : s, 15 000 p : s, 19 000 p : s, 23 000 p : s and 27 000 p : s. The carrier and the upper side-band are suppressed. The same frequency is used for both directions of transmission and, in order to reduce crosstalk, two cables are used. Since paired cables have a smaller effective resistance, but are more cumbersome and have less regular unbalances, a suitable method of manufacture of such cables is being studied.

Question No. 1 ter. Specification for Television Circuits (Category A2). 3rd C.R. in collaboration with UIR.

What should be the essential characteristics of international circuits used for television and what conditions should be imposed on these essential characteristics ?

Question No. 2. Noise Limits (Category A2). 3rd C.R. with collaboration of 4th C.R. and 1st C.R. (Continuation of Question No. 2 of 1935/1936.)

(*a*) What is the maximum limit of noise E.M.F. permissible on a continental international telephone communication, and how should this maximum value be divided between the three sections making up the connection : national sending system, international circuit, national receiving system ?

Note.—With regard to the international circuit, distinction should be made between a direct connection and a transit connection ; in the latter case the maximum value allowed for the noise E.M.F. should be divided between the different international circuits.

(*b*) In the case of an open-wire line without repeaters, what value should be allowed, under the worst conditions met in practice, for the induced noise E.M.F., measured at the end of the open-wire line, with the exchange equipment disconnected and the line itself terminated with its characteristic impedance ?

(*c*) In the case of a cable circuit, what value should be allowed, under the worst conditions met in practice, for the induced noise E.M.F. measured at the end of the cable with the repeaters and exchange equipment disconnected and the line itself terminated with its characteristic impedance ?

Note.—It is understood that, in order to fix limits for the noise E.M.F. (part (*a*) Question 2), all the noise on the circuit should be included—induced noise, telegraph noise, clicks, crosstalk, etc. (see Question 2 bis below). Having taken all precautions on the lines and telephone installations to reduce as far as possible all noise other than induced noise, the part attributed to noise induced by neighbouring traction lines and power lines (parts (*b*) and (*c*) of Question 2) can be definitely fixed.

Question No. 2 bis. Noise Impairment (Category A1). 3rd C.R. with collaboration of 4th C.R. (Continuation of Transmission Question No. 2 bis of 1935/1936.)

What is the reduction in the quality of transmission, expressed in nepers or decibels, due to the permissible noise on the international circuits ?

Note.—The noise induced from power lines or neighbouring traction lines is not taken into consideration. The effects to be studied are microphonic noise, crosstalk, telegraph noise, noise from repeater power supply, clicks, etc.

Question No. 3. Noise Impairment Curve (Category A1). 3rd C.R. with collaboration of 1st and 4th C.R.'s.

Would it be possible, based on the articulation tests made by the SFERT laboratory during 1935 and 1936 to determine a curve whose abscissa would be the C.C.I.F. psophometer readings (in milivolts) when the psophometer (network A) is connected across the listening subscriber's telephone, the impedance of which is held to 600 ohms, and whose ordinates would be the noise transmission impairment due to the line noise measured ?

Note.—See page 85 (White Book Vol. I bis, page 93) for provisional table giving the noise impairment in decibels as a function of the psophometric voltage measured at the central office with the C.C.I.F. psophometer (network A) connected across a resistance of 600 ohms terminating the Toll line, an impedance matching transformer being used.

Question No. 3 bis. B-Network for Psophometer (Category A1). 3rd C.R. with collaboration of 4th C.R.

Would it be possible to specify an additional network (network B) capable of representing as an average the variation with frequency of the line and equipment found, in service, between the terminals of the toll line and the terminals of the receiver of the listening subscriber ?

Note.—If this were possible, one could, from a psophometric measurement made at the terminals of a toll line, deduce the noise transmission impairment for a given toll line noise.

Question No. 3 ter. Use of Psophometer for Measuring Discontinuous Noises (Category A1). 4th C.R. with collaboration of 3rd C.R.

Given the fact that the psophometer has been developed especially to measure continuous noises, and that there still remain as unspecified all transitory characteristics of noise, would it not be possible to specify the make-up of the psophometer (filter networks and indicating equipment) in such a way that it would be possible, without changing the method of measuring continuous noises, to obtain for variable noises (frying noises, clicks, telegraph noise, etc.) a reading corresponding to the effect of these noises on the ear ?

Question No. 4. General Toll Plan for Europe (Category A2). Mixed Commission of 3rd, 4th and 6th C.R.

In order to facilitate agreement between the Telephone Administrations and Operating Companies of Europe upon the grade of normal circuits, auxiliary circuits, and emergency circuits (Telephone Regulations attached to the International Telecommunication Convention, Article 3, Paragraph 3), what general guiding principles should be recommended for such grading ?

Would it be possible to arrange a general toll plan for Europe by means of the application of such guiding principles ?

Note.—The study of this question is deputed to a Mixed Committee of Operating and Technical representatives constituted as follows :—

Operating Representatives :—

Germany	Mr. Ehlers
Belgium	Mr. Fossion
Spain	.....
France	Mr. Debry
Great Britain	Mr. Gomm
Hungary	Dr. Havas
Sweden and other Scandinavian countries	Mr. Halling
Switzerland	Mr. Moeckli

Technical Representatives :—

Germany	Messrs. Gladenbeck and Oehlen
Denmark	Mr. Holmblad
France	Mr. Malézieux
Great Britain	Messrs. Timmis and Chamney
Hungary	Dr. Tomits
Poland	.....
Rumania	Mr. McCurdy
Czechoslovakia	Mr. Stowasser
U.S.S.R.	Prof. Lapirov Skoblo
Technical Consultant	Dr. Osborne (A.T.T.Co.—U.S.A.)
Secretary	Mr. Parmentier

Note 2.—To collect all the data required for the study of the guiding principles for the establishment of a general toll plan for Europe, the Secretariat of the C.C.I.F. will send to the various Telephone Administrations and Operating Companies the following questionnaires :—

Questionnaire No. 1.

1. Which are the Terminal Exchanges (T) for international circuits (excluding circuits serving frontier regions) ?

Show on a map the zone served by each Terminal Exchange.

2. Which are the provincial Transit Centres (P) used in each country for handling international traffic ?

(For each Transit Centre an indication should be given whether or no a transmission gain is introduced in the circuit (by cord circuit repeater or by cutting out a pad)).

3. What is, at the provincial Transit Centres, the constitution of the circuit for a typical call and for the worst case of a call between a provincial Transit Centre and any of the subscribers it serves, especially from the standpoint of :—

(*a*) length of the various sections composing the circuit.

(*b*) the various types of loading.

(*c*) the overall attenuation (under transit conditions) of its various sections.

(*d*) the average and maximum number of exchanges, if any, between the provincial Transit Centre and the subscriber (see below for example of form to be used to facilitate subsequent comparison).

The limits between which the adjustment of the various types of circuit normally vary, should also be stated.

Further, for each provincial Transit Centre the average daily number of 3-minute units of international conversation established by means of this Transit Centre should be given, as well as the principal directions of this traffic so far as it can be stated.

The worst case of a call mentioned above is that on a circuit whose limits of variation of the different factors taken into consideration in re-establishment of the national programme are the most unfavourable.

If an Administration or Operating Company contemplates any considerable modification of its national toll plan in the near future it is advisable that details of the present and future arrangements should be stated.

4. In addition, international connections, which necessitate the use of more than two international circuits, should be specified together with the traffic on the same.

Questionnaire No. 2.

A. Characteristics of the echo-suppressors used in the various countries from the point of view of sensitivity.

(*a*) How does the additional attenuation introduced by the echo-suppressors vary with the voltage at the input ?

(*b*) How does this additional attenuation vary with frequency ?

B. Characteristics of the echo-suppressors as concerns operating time, partial closing time, and hang-over time.

(*a*) How does the operating time vary with the input voltage ?

(*b*) How does the partial closing time vary with the input voltage ?

(*c*) How does the hang-over time vary with the input voltage ?

Note.—When the information requested in the two foregoing questionnaires has been received by the Secretariat of the C.C.I.F. (before the 1st December, 1936), it will be sent to the members of the Mixed Committee mentioned above and studied by that Committee.

It has been recognised to be desirable to agree upon methods of calculating and testing the more important characteristics of circuits. One of the most important effects being that of echo, the XIth A.P. at Copenhagen has adopted the method to be followed for calculating the minimum overall attenuation permissible under service conditions from the point of view of echo effect on a circuit having echo-suppressors (see White Book, Vol. I. bis page 146).

A similar method has already been adopted for circuits not equipped with echo-suppressors.

To apply this method to circuits equipped with echo-suppressors the Mixed Committee must produce a curve fixing the minimum overall attenuation for echo currents as a function of the time of propagation of the circuit.

Upon the termination of the study by the Mixed Committee of the replies to the above two questionnaires the various Administrations and Operating Companies will be asked to determine the technical transmission characteristics of the various classes of lines and circuits in their territory, in accordance with methods of calculation and testing which will be specified by the Mixed Committee. These data also will be sent to the C.C.I.F. to be forwarded to the members of the Mixed Committee, who will then hold another meeting (about the month of September, 1937) to fix the values which will be specified in future, taking into account as far as possible the values of transmission characteristics which they will have received.

Then after this second study, the general toll plan for Europe will be so arranged as to improve as much as possible the efficiency of international circuits by forming as many groups as possible.

Specimen of form to be used for the information requested in paragraph 3 under (*a*), (*b*) and (*c*) of questionnaire No. 1.

A. Connection between the provincial transit centre (P) and the subscriber.

Class of circuit.	Connection :— Subscriber to Distribution Centre. Overall (1) attenuations at 800 p : s Neper.	Connection :— Distribution Centre (D) to Transit Centre (P). Name of specimen circuit.	Type	Details of circuit.	Number and location of Repeaters.	Transit overall attenuation Neper.	Percentage of Connections of the various types.	Remarks.
Type 1 Connection	0.60	Lille-Béthune	2 Wire	90 km H 177/63 0.9 mm	1 interm 1 term	0.50	60%	
Type 2 Connection	0.70	Lille-St. Pol.	2 Wire	70 km open wire 2.5 mm	1 term	0.60	30%	

Note 1.—The overall attenuation of the connection Subscriber to Distribution Centre (D) should include the attenuation due to the Distribution Centre exchange and the toll exchanges, if any.

Note 2.—The Transit overall attenuation of the connection Distribution Centre (D) to the Provincial Transit Centre (P) should include the attenuation due to the Transit Centre exchange.

Note 3.—The number of intermediate repeaters on the circuit should be shown by the number followed by the letter i. Terminal repeaters should be shown by the number followed by letter t.

Note 4.—Should it not be possible to select one typical connection it will be satisfactory to select 2 or 3 typical connections, stating the percentage number of each of the various types concerned.

B. Connection between the transit centre (P) and the international terminal exchange (T).

Class of Circuit.	Type	Details of Circuit.	Number and Location of Repeaters.	Number and Location of Echo-Suppressors.	Transit Overall Attenuation (Neper).	Percentage Connections of the various types.	Remarks.
Connection Type 1.	4 Wire	360 km H 44/18 0.9 mm Phantom	5		0.30		
Connection Type 2.	4 Wire	815 km H 44/18 0.9 mm Side	11		0.30		
Poorest quality connection.							

Note.—See notes 3 and 4 under the preceding form.

Question No. 5. Characteristics of Echo-Suppressors (Category A1). 3rd C.R. with collaboration of 4th C.R. (Continuation of Transmission Question No. 5 of 1935/1936.)

(*a*) What is the maximum allowable operating time for an echo-suppressor and what are the allowable variations in the operating time as a function of the power applied at the input of the echo-suppressor ?

(*b*) What should be the frequency for which the echo-suppressor should be the most sensitive ? What should be the relation between the sensitivity at this most critical frequency and the sensitivity when operated by normal voice currents ?

(*c*) How should one vary the sensitivity of an echo-suppressor as a function of frequency for frequencies above and below this most critical frequency ?

(*d*) What are the allowable variations in hang-over time when the applied power is varied between the limits corresponding to the normal operating time for the echo-suppressor ?

(*e*) Would it be advisable to fix limits for the delay in the portion of international line between the two most distantly separated suppressors ?

Note.—One may, in connection with point (*e*) distinguish between two cases :—
(1) the case where both halves of the echo-suppressor are located at the same point ;
(2) the case where the two halves of the suppressor are at different points in the circuit.

There is need to study this question keeping in mind all types of disturbances which it is possible to observe : these various disturbances are analysed in the following annex.

(*f*) Should the definitions in connection with the operation of echo-suppressors provisionally admitted by the XIth Plenary Meeting of the C.C.I.F. at Copenhagen in June, 1936, be modified in accordance with the suggestions contained in Annex 5 below ?

Annex 1 to Question No. 5.

Analysis of disturbances which may be caused by echo-suppressors.

In four-wire circuits echo-suppressors can produce the following disturbances :—

1. Two echo-suppressors may function simultaneously. This happens when the two subscribers A and B (see Fig. 1) commence to speak at about the same time. There is then a " gap " in the

conversation from A to B, because voice currents from B have already passed echo-suppressor E_A before voice currents from A have caused the operation of the echo-suppressor E_A.

Echo-suppressor E_B is then operated for a short interval, and the direction A-B is blocked. Subscriber A is disturbed by hearing just the beginning of the conversation from B. Such a disturbance always occurs when the time between the beginning of the conversation from A and from B is equal to or less than the value.

$$(t_1 + t_2 - t_3)$$

This disturbance does not exist when the echo-suppressors E_A and E_B are both placed in the middle of the circuit, that is :—

$$t_1 = t_3 \text{ and } t_2 = 0.$$

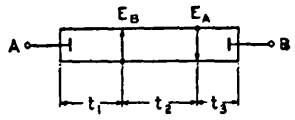


FIG. 1.

2. The hang-over time, or duration of return to zero of the echo-suppressors, prevents one subscriber from breaking in on the conversation from the other subscriber. The hang-over time of suppressor E_A should have a value t_a greater than $2t_3$, and the hang-over time of suppressor E_B should have a value t_b greater than $2t_1$. If these times are too great, the natural intervals between syllables occurring in the course of a conversation are more than covered by voice currents, and breaking in is not possible ; finally, a subscriber cannot break in during a pause in the conversation from the other subscriber.

From this point of view it seems desirable to place the echo-suppressors at the ends of the circuit so that :—

$$t_1 = 0 \text{ and } t_3 = 0.$$

3. In the case where two or more circuits equipped with echo-suppressors are interconnected (see Fig. 2), mutual jamming takes place, the two directions A-B and B-A both being permanently jammed.

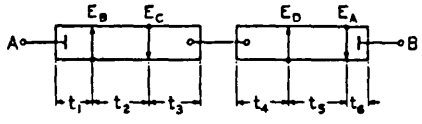


FIG. 2.

It may happen, when both subscribers A and B speak, that the suppressors E_C and E_D are operated so that neither subscriber can hear the other. This trouble can be avoided by removing the superfluous echo-suppressors E_C and E_D or by reversing their direction.

Annex 2 to Question No. 5.

Certain experiments carried out in Germany and in the United States regarding disturbances which might be caused by echo-suppressors have given results which do not agree with each other. This disagreement in results arises from the differences which exist in equipment used in each of these countries and also a difference in certain psychological factors. The results obtained are as follows :—

In the United States of America the relay type suppressor is generally used. It has been found that a via circuit made up of two circuits each equipped with a complete suppressor at the mid-points gives rise to more disturbance than when, with the same circuit, half-suppressors are used.

One of the most important causes of the increase in disturbances is " lock out " (" blockage réciproque ").

Since it has been found by a number of tests that the disturbances (evaluated by repetition tests) increase as the lockout zone increases, the A.T. & T. Co. is continuing to limit the delay between the two most distantly separated suppressors to 100 m.s. Tests on the action of echo-suppressors in tandem are being continued. (See Annex 3, below.)

In Germany various tests have been carried out in which two subscribers, without knowing it, talk over a circuit equipped with echo-suppressors. By listening on the circuit, the disturbance, if any, experienced by the subscribers as a result of the echo-suppressor is observed for various given delays. The percentage of conversations exchanged with no disturbance as compared with the total number of conversations exchanged was noted (both for the case of one pair of echo-suppressors and for the case of two pairs of suppressors). Based on these experiments one may conclude that there is no technical basis for limiting the delay between the two most distantly separated suppressors on an international connection. Without hesitation, it would be possible to take the total allowable delay for the overall connection, that is, 250 m.s. (White Book, Volume III, p. 140, English Edition p. 232) as the allowable delay between the two most distantly separated suppressors.

Regarding the danger of lockout resulting from superfluous echo-suppressors in an international connection, the results of the German tests show that the risk of lockout depends upon the total delay between the two subscribers and is independent of the delay between the echo-suppressors.

If, on a switched connection, the delay is less than 1/5th second, the risk of lockout is so small that no special means need be adopted for cutting out extra suppressors.

Consideration has been given to the case where the direction of the two superfluous echo-suppressors is reversed. The results show that less benefit is obtained from this procedure than if the same suppressors are cut out of the circuit.

Finally, the German tests comprising observations on several thousand conversations, show that lockouts of long duration were never experienced, and never were more than a few isolated words or syllables suppressed.

If oscillograph records of the voice currents are taken it will be found that there are pauses of several hundredths of a millisecond between different words, with the result that between the enunciation of two successive words by the subscriber at, say, the east end, the west-to-east path is free, and vice versa. As a result, when two subscribers speak at the same time, each one, between the words which he speaks, hears portions of the speech from the other subscriber, and a lockout of long duration cannot occur.

On all four-wire circuits it will be advantageous in the future to place the echo-suppressors at the ends of the circuit, in the terminating sets, in the case of multiple use of lines (carrier telegraphy or telephony). It would then be possible to utilise completely the portion of the four-wire circuit situated between the two terminating sets, not only for carrier telegraphy or telephony but also for the transmission of signalling or dialling impulses, pilot currents for automatic regulation, etc., without having the transmission on any one channel interfered with by the action of the echo-suppressor, resulting from currents from another channel.

In addition it is also possible, with terminal echo-suppressors, to cut out of the circuit in an easy manner, extra or superfluous echo-suppressors since the necessary equipment for this can be localised in the terminating telephone offices.

Annex 3 to Question No. 5.

Observations of the American Telephone and Telegraph Company on the disturbing effects which may be produced in a telephone connection containing one or more echo-suppressors located at the centre or at the ends of the circuit.

This information uses certain typical connections and makes certain assumptions as to the time at which a subscriber at one end of the circuit starts to talk in response to the subscriber at the other

end. In any actual conversation the effects are, of course, considerably more complicated, being affected by the speed with which individual subscribers talk, whether or not a subscriber attempts to interrupt while the other subscriber is still talking, etc. It is believed that the information given below will serve as a basis for the further discussion and study being given the matter of the detrimental effects caused by echo-suppressors under certain conditions.

Some of the more important effects which are caused by echo-suppressors are :—

(*a*) They make it difficult for the listener to interrupt or break into the speech of the talker.

(*b*) They may block the speech of both subscribers, causing lockout if both subscribers begin speaking at about the same time.

(*c*) They may mutilate or cut out short intervals of the received speech.

The sketches below indicate graphically typical effects which may result with :—

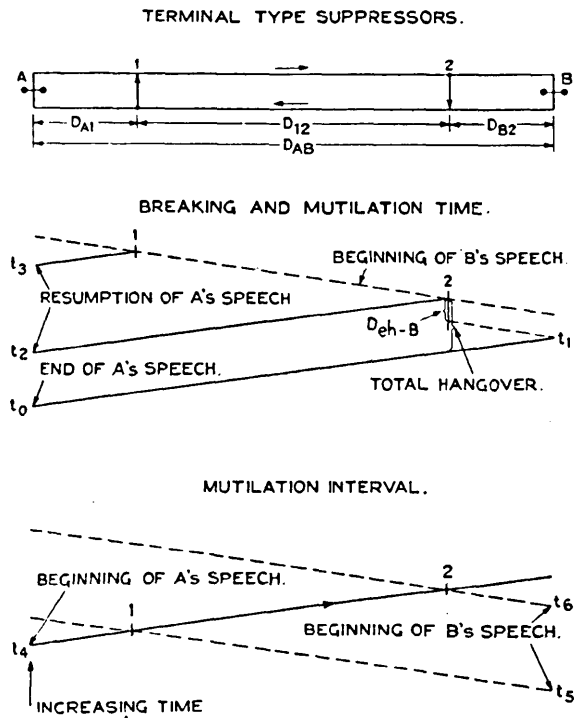
(*a*) Those connections involving only one echo-suppressor point in each direction of transmission.

(*b*) Those connections involving two echo-suppressor points in each direction of transmission.

In each case separate sketches are given for the two types of suppressors covered in Question No. 5, that is, central echo-suppressors and terminal echo-suppressors having one-half of the suppressor located at or near the receiving terminal of the circuit. In each case it is assumed that the echo-suppressor hangover is at least great enough to take care of the echoes from the terminal of the circuit on which it is located and that the excess hang-over is moderately small and about the same for all echo-suppressors. The operating time of the echo-suppressors, being comparatively small, is neglected in the discussion which follows.

Connections Involving One Suppressor Point in Each Direction of Transmission.

This type of connection is shown on the sketches A and B for the terminal and central types of suppressors, respectively.



SKETCH A.

Connections involving one suppressor point in each direction of transmission.

Referring to the upper diagram of Sketch A, the line designated " End of A's speech " is assumed to be the time at which A pauses during the course of the conversation either to allow B to answer, or as a natural pause in the course of the conversation. This pause occurs at the A end of the circuit at the time t_0. The delay in the circuit determines the slope of the line " End of A's speech," so that the pause which originates at t_0 is not apparent to B until some time indicated as t_1. If subscriber A resumes speaking within the interval between t_0 and t_2, subscriber B's speech will be blocked. This is due to the fact that A's speech will be impressed on echo-suppressor 2 prior to the time when this suppressor would have released from A's earlier speech due to the hang-over. Therefore, the echo-suppressor will remain operated and block B's speech. If subscriber A resumes speaking within the interval from t_2 to t_3, B's speech will be received by A but will be mutilated or partially locked out since during this period the first part of A's speech will pass suppressor 1 before B's speech has reached suppressor 1, and this part of A's speech will temporarily operate suppressor 2 and cut out a portion of B's speech.

Referring to the lower diagram of Sketch A, if subscriber A begins speaking at time t_4 and subscriber B begins speaking within the interval from t_5 to t_6, B's speech will reach A but will be mutilated by the temporary operation of suppressor 2 as a result of the short spurt of A's speech which passed suppressor 1 before B's speech reached this suppressor.

From Sketch A and the above discussion it is apparent that the expressions for the various intervals will be as follows :—

Referring to the upper diagram :

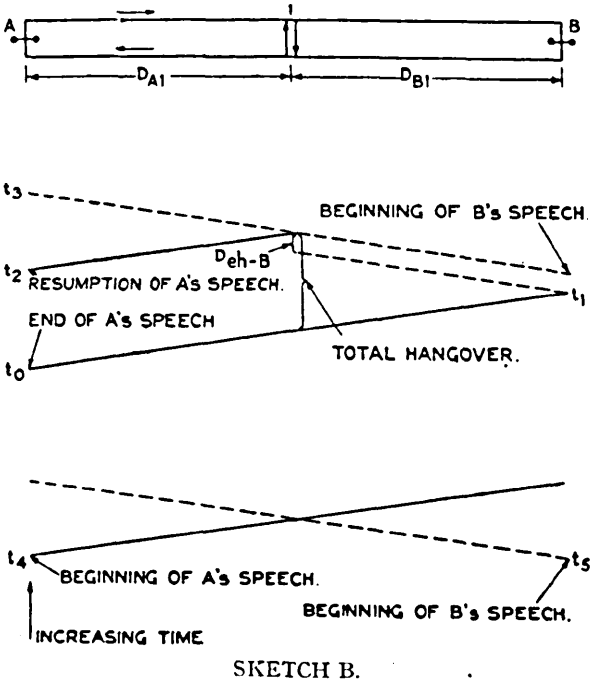
$$t_2 - t_0 = D_{A1} + D_{12} + D_{B2} + D_{eh\text{-}B} + D_{B2} - D_{12} - D_{A1} = 2D_{B2} + D_{eh\text{-}B}$$

It will be noted that $t_2 - t_0$ is the total hang-over of suppressor 2.

$$t_3 - t_2 \text{ (Mutilation)} = D_{A1} + D_{12} + D_{12} - D_{A1} = 2D_{12}$$

Similar intervals from the B end of the circuit are :

$$(2D_{A1} + D_{eh} - B) \text{ and } 2D_{12}$$



SKETCH B.

Connections involving one central type echo suppressor.

Referring to the lower diagram :

$$t_2 - t_1 \text{ (Mutilation)} = (t_0 + D_{A1} + D_{12} - D_{B2}) - (t_0 + D_{A1} - D_{12} - D_{B2}) = 2D_{12}$$

The expressions $D_{eh\text{-}A}$ and $D_{eh\text{-}B}$ denote the excess hangover at the A and B end of the connection, respectively.

On Sketch B intervals similar to the above are given for the case of central type echo-suppressors. In this case D_{12} is, of course, zero and the various times are as follows :—

$$t_2 - t_0 = D_{A1} + D_{B2} + D_{eh} - B + D_{B2} - D_{A1} = 2D_{B2} + D_{eh\text{-}B}$$

It will be noted that $t_2 - t_0$ is the total hang-over of the suppressor.

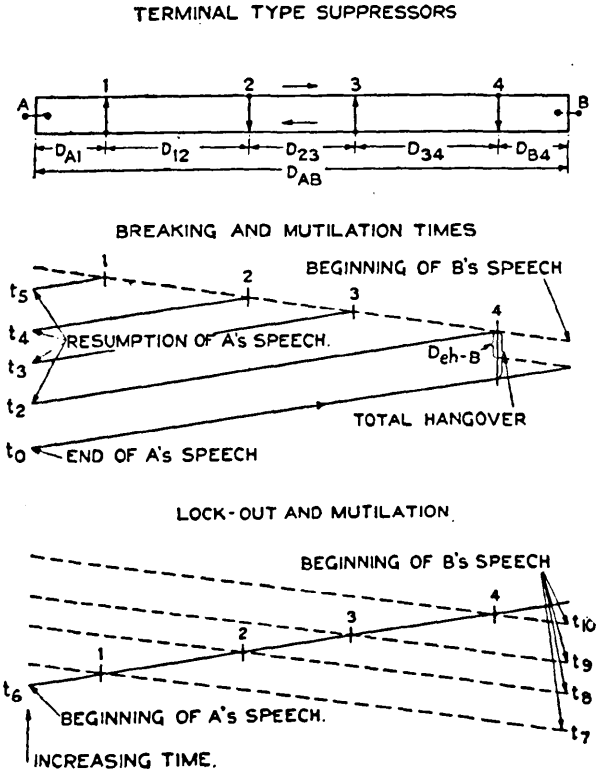
The similar interval from the B end of the circuit is :

$$2D_{A1} + D_{eh\text{-}A}$$

In this case there is no interval during which mutilation occurs.

Connections Involving Two Echo-Suppressor Points in Each Direction of Transmission.

This type of connection is shown on Sketches C and D, and applies to a connection in which at least two links are equipped with echo-suppressors. Sketch C applies to the terminal type echo-suppressors and Sketch D to central type suppressors. Referring to the upper diagram of Sketch C, the line " End of A's speech " indicates a pause in A's conversation starting at time t_0, which pause is first noticed by B at time t_1. If subscriber A resumes speaking within the interval from t_0 to t_2, subscriber B will be unable to " break " or interrupt A. This is due to the fact that A's speech will be impressed on echo-suppressor 4 before this echo-suppressor has had a chance to release, due to the hang-over. If A resumes speech in the interval from t_2 to t_3, suppressor 4 will have a chance to release and a spurt of B's speech will get by to temporarily operate suppressor 3 and so mutilate A's



SKETCH C.

Connections involving two suppressor points in each direction of transmission.

speech. Whether A finally gains control of the circuit or lockout occurs depends upon several factors, among them the relative values of the hang-over of suppressors 3 and 4. If A resumes speech during the interval from t_3 to t_4 suppressor 2 will be operated by A and suppressor 3 by B so that lockout will occur and neither conversation will get through. If A resumes speech in the interval from t_4 to t_5, B's speech will be received, but will be mutilated by the temporary operation of echo-suppressor 2 by a spurt of A's speech.

Referring to the lower diagram of Sketch C, if subscriber A begins speaking at time t_6 and subscriber B begins speaking within the interval from t_8 to t_9 both B's speech and A's speech will be blocked. This is due to the fact that during this period A's speech will reach suppressor 2 before B's speech, blocking the B to A path, and B's speech will reach suppressor 3 before A's speech, blocking the A to B path. Both paths will remain blocked while both subscribers continue to talk. If B begins to speak within the interval from t_7 to t_8, his speech will reach A but it will be mutilated by the temporary operation of suppressor 2 as a result of a short spurt of A's speech which passed suppressor 1 before B's speech reached his suppressor. Whether B finally gains control of the circuit or lockout occurs depends upon several factors, among them the relative values of the hang-over of suppressors 1 and 2. If B begins to speak within the interval t_9 to t_{10}, his speech will not reach A but it will mutilate A's speech since the short spurt of it which passed suppressor 4 before A's speech reached this suppressor will temporarily operate suppressor 3.

From Sketch C and the above discussion it is apparent that the expressions for the various intervals will be as follows :—

Referring to the upper diagram :

$$t_2 - t_0 = D_{A1} + D_{12} + D_{23} + D_{34} + D_{B4} + D_{eh\text{-}B} + D_{B4} - D_{34} - D_{12} - D_{A1} = 2D_{B4} + D_{eh\text{-}B}$$

It will be noted that $t_2 - t_0$ is the total hang-over of suppressor 4.

$$t_3 - t_2 \text{ (Mutilation)} = D_{A1} + D_{12} + D_{23} + D_{34} + D_{34} - D_{23} - D_{12} - D_{A1} = 2D_{34}$$

$$t_4 - t_3 \text{ (Lockout)} = D_{A1} + D_{12} + D_{23} + D_{23} - D_{12} - D_{A1} = 2D_{23}$$

$$t_5 - t_4 \text{ (Mutilation)} = D_{A1} + D_{12} + D_{12} - D_{A1} = 2D_{12}$$

The minimum time for which A must pause in order to recognise B's attempt to respond is $(t_2 - t_0) + (t_3 - t_2) + (t_4 - t_3) = 2D_{B4} + D_{eh\text{-}B} + 2D_{34} + 2D_{23}$.

Similarly it can be shown that the minimum time for which B must pause in order to recognise A's attempt to respond is :

$$2D_{A1} + D_{eh\text{-}A} + 2D_{12} + 2D_{23}$$

Referring to the lower diagram :

$$t_9 - t_8 \text{ (Lockout)} = (t_6 + D_{A1} + D_{12} + D_{23} - D_{34} - D_{B4}) - (t_0 + D_{A1} + D_{12} - D_{23} - D_{34} - D_{B4})$$
$$= 2D_{23}$$

$$t_8 - t_7 \text{ (Mutilation)} = (t_6 + D_{A1} + D_{12} - D_{23} - D_{34} - D_{B4}) - (t_6 + D_{A1} - D_{12} - D_{23} - D_{34} - D_{B4})$$
$$= 2D_{12}$$

$$t_{10} - t_9 \text{ (Mutilation)} = (t_6 + D_{A1} + D_{12} + D_{23} + D_{34} - D_{B1}) - (t_6 + D_{A1} + D_{12} + D_{23} - D_{34} - D_{B1})$$
$$= 2D_{34}$$

Referring to the upper diagram of Sketch D, if subscriber A resumes speaking within the interval from t_0 to t_2, B will hear A but subscriber B will be unable to make himself heard since A's speech will be impressed upon suppressor 2 before this suppressor has had a chance to release due to its hang-over. If subscriber A resumes speech in the interval from t_2 to t_3, the speech of both subscribers

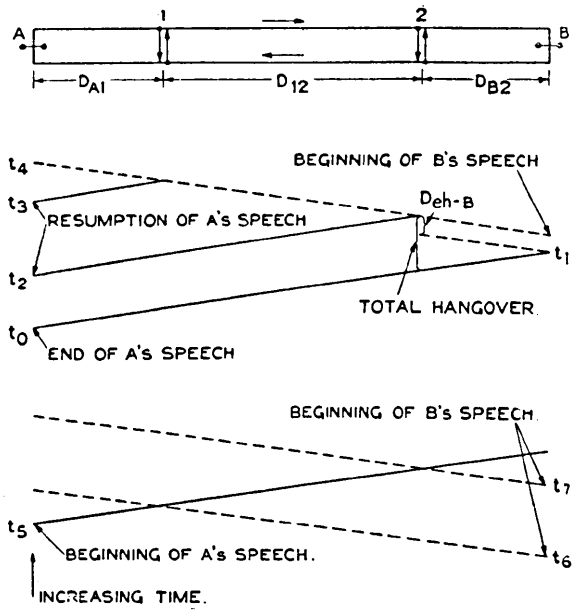
will be blocked since A's speech takes control of suppressor 1 and B's speech takes control of suppressor 2.

Referring to the lower diagram of Sketch D, if subscriber A begins talking at t_5 and subscriber B begins talking in the interval t_6 to t_7, both A's and B's speech will be blocked because A's speech will operate suppressor 1 before B's speech can get by it, and B's speech will operate suppressor 2 before A can operate suppressor 2. It is apparent from the above discussion and Sketch D that the various time intervals may be expressed as follows :—

$$t_2 - t_0 = D_{A1} + D_{12} + D_{B2} + D_{eh\text{-}B} + D_{B2} + D_{12} - D_{A1}$$
$$= 2D_{12} + 2D_{B2} + D_{eh\text{-}B}$$

$t_3 - t_2$ (Lockout) $= D_{A1} + D_{12} + D_{12} - D_{A1} = 2D_{12}$

$t_6 - t_5$ (Lockout) $= (t_4 + D_{A1} + D_{12} - D_{B2}) - (t_4 + D_{A1} - D_{12} - D_{B2})$
$= 2D_{12}$



SKETCH D.
Connections involving two central type echo suppressors.

The American Telephone and Telegraph Company recommends that each Administration study further the various impairments caused by the addition of echo-suppressors to circuits, typical examples of which are given above, in order to determine quantitatively the magnitude of the impairment caused by them on circuits of different lengths. After this work is completed, it is believed that sufficient information will then be available to allow C.R.3 to recommend maximum permissible limits for each effect. Whether this limit would be expressed as the maximum delay between echo-suppressors, the maximum amount of hang-over, a combination of these two effects or some other quantity would be determined by the results of these studies.

Annex 4 to Question No. 5.

Summary of British Post Office tests on Lockout Effects with Echo-Suppressors.

The British Post Office carried out in February, 1936, a series of tests to determine the importance of lockout when echo-suppressors are used at both ends of a line having a propagation time greater than 100 m.s.

In order to check the opinion issued by the American Telephone and Telegraph Company and the German Administration, tests were made on a 6 000 km line having a maximum propagation time of 300 m.s. and on which it was possible to use terminal echo-suppressors at each end with or without an intermediate suppressor. Lockout was indicated visually and the time recorded. The number of repetitions was noted at the time when lockout occurred and at other times.

A large number of conversations took place between members of the research department under conditions as nearly normal as possible, though, of course, slightly different from regular commercial traffic.

Three different propagation times were used : 100, 200 and 300 m.s.

The results were as follows :

(*a*) A lockout of less than one second duration can be neglected since such a lockout gives rise to a negligible number of repetitions.

(*b*) The number of lockouts was found to be 0.7 per 100 seconds of conversation for a propagation time of 200 m.s. This corresponds to a repetition rate quite satisfactory in practice—less than 0.6 per 100 seconds of conversation. This takes place only when the limit of propagation time from the standpoint of delay between question and answer, without bringing into consideration echo-suppressors, has been almost arrived at. Certain of the repetitions noted were undoubtedly due to this latter cause.

These results, moreover, are in close agreement with the tests made by the German Administration, and it is apparent that there is no danger in placing echo-suppressors at the two ends of a line having a propagation time of 200 m.s.

The echo-suppressors used were of the continuous acting type (copper oxide rectifier).

Annex 5 to Question No. 5.

Proposed Modifications to Definitions relative to the Operation of Echo-Suppressors.

(1) Various types of echo-suppressors.

It is proposed to insert the following definitions in order to be able to classify echo-suppressors not only by their method of operating (locking or non-locking) but also by their position in the telephone transmission system.

An **intermediate echo-suppressor** (Unterwegsechosperre, suppresseur d'écho intermédiaire) is one which is placed preferably at the output of an intermediate repeater situated at the approximate middle of a four-wire circuit, the two halves of the echo-suppressor being in the same repeater station.

A **terminal echo-suppressor** (Gabelechosperre, suppresseur d'écho terminal) is one placed at each end of a four-wire circuit at the input or output as the case may be of the receiving terminal repeater, each half of the echo-suppressor being installed in the appropriate repeater station.

(2) Sensitivity.

To indicate the method of working of a transmission system equipped with echo-suppressors, the relation of the levels is usually considered. It therefore appears undesirable to describe the operation of echo-suppressors by such a factor as " sensitivity," which is expressed as an attenuation. It is proposed to introduce the term " operating level " (Ansprechpegel, niveau de fonctionnement) in place of " sensitivity "—the " operating level " being equal in absolute value but opposite in sign to the " sensitivity." To the " local sensitivity," then, would correspond the " operating level," indicating the voltage to be applied to the input of the echo-suppressor to make it operate. " Zero

level operating level " (Nullpunktsansprechpegel, niveau de fonctionnement rapporté au niveau relatif zéro) indicates the voltage to be applied to the input of the transmission system so that the echo-suppressor installed on the system may operate, and thus replaces the term " sensitivity referred to zero relative level."

Actually, it is this operating level which is concerned when the maximum admissible sensitivity for an echo-suppressor is expressed as a negative number of nepers or decibels.

(3 to 8) **Determination of operating time, hang-over time, and partial closing time of a locking type echo-suppressor.**

For the determination of the above it is proposed to apply to or quickly break at the input of the echo-suppressor a sinusoidal voltage of a frequency equal to that at which the echo-suppressor is most sensitive and of which the value is twenty times (and not twice) that of the value of voltage used to define the local sensitivity (operating level) of the echo-suppressor.

For low voltages in fact, the switching time (operating and hang-over) depends largely upon the amplitude, and in a manner very different for various echo-suppressors. On the other hand, for large amplitudes the switching time is almost independent of the amplitude, and in consequence two echo-suppressors whose switching times are the same when tested at small amplitudes may behave in an entirely different manner at large amplitudes, that is, within the voltage band met with in service. It is therefore advisable to determine these switching times for the voltages met with in actual use; this band is characterised by the fact that the absolute voltage level at the input of the echo-suppressor is equal to the relative voltage level at the point of the circuit where the echo suppressor is installed.

The voltage at the input of an echo suppressor the average sensitivity (operating level) of which referred to zero relative level is – 3 nepers, is therefore 3 nepers above the operating voltage (that is, is 20 times as great as the operating voltage).

Finally, it is proposed to define as follows the partial closing time of a blocking type echo-suppressor (Teilsperrzeit, fermeture partiel): " It is the time between the moment when the wave defined above ceases to be applied to the input of the echo-suppressor and the moment when the additional attenuation on the blocked channel has fallen to 2.3 nepers or 20 decibels (in place of 3.0 nepers or 26 decibels)." In fact, the presence of an attenuation of 3.0 nepers on the blocked channel shows that the voltage at the output of the attenuator is equal to one twentieth of the total output voltage. As the measurement of partial closing time is mostly made by means of oscillograms, and as the reading of an ordinate equal to one twentieth of the final amplitude is in practice very vague, it is preferable to consider a larger fraction (say one-tenth) of the final amplitude to define the partial closing time of an echo-suppressor.

Question No. 6. Interconnection of Two Radio Links by Land Line (Category A1). 5th C.R. with collaboration of 3rd C.R.

What measures should be taken, when interconnecting two radio links by means of a land line, when the two intermediate offices use different types of echo-suppressors (for instance, one using the relay type and the other using the valve or dry-rectifier type with gradual operation) ?

Question No. 7. Secrecy Devices for Radio Telephone Circuits (Category B). 5th C.R. with collaboration of 3rd C.R.

What are the arrangements to be employed by the various Administrations and Operating Companies for obtaining secrecy on radio-telephone communications ? What are the characteristics of the equipment to be used (distortion of various types, etc.), and what should be its position with respect to the other parts of the connection ?

Question No. 8. Control of Volume Variation in Broadcast Circuits (Category A2). 3rd C.R. with collaboration of 5th C.R.

(*a*) Is it desirable to employ automatic devices to limit or compress the variation in volume at the input of a circuit used for transmitting music and to re-establish the original variation at the receiving end ? In the affirmative what should be the characteristics to be specified for such devices ?

(*b*) If an automatic device is used to limit the variation in circuit input volume and to re-establish, at the circuit output, the original volume variations, is it desirable to associate with this device an automatic device which will maintain the average volume at a determined optimum value ?

Note.—A relatively small difference between the two volume extremes during the transmission is desirable :—

(*a*) in the case of wire transmission in order to eliminate overloading and its known resulting effects (non-linearity, etc.), and

(*b*) in the case of radio transmission for the same reason and in order to better the signal-to-noise ratio.

Principal documents covering this question are :—

(1) Ueber Automatische Amplituden begrenzer : Elektrische Nachrichten Technik 1928, No. 11 ; H. F. Meyer.

(2) The Compandor : *Bell System Technical Journal*, July 1934 ; Mathes and Wright.

(3) Amplitudenabhängige Verstärker, Electrotechnische Zeitschrift 1934, No. 36 ; W. Nestel.

(4) Die Arbeitsweise der Selbstätigen Regalapparaturen : Electrische Nachrichten Technik, Vol. 12, No. 11, 1935 ; H. Bartels and G. Ulbricht.

Question No. 9. False Operation of Echo-suppressors (Category A1). 5th C.R. with collaboration of 3rd C.R. (Continuation of Transmission Question No. 9 of 1935/1936.)

What means are to be recommended to avoid false operation of echo-suppressors on an international telephone connection using radio links and land lines ?

Note.—The following arrangements are foreseen in various countries :—

(*a*) " Positive action " echo suppressors in which the receiving path is not opened except when voice frequency signals are actually being received.

(*b*) Echo suppressors in the land lines whose sensitivity is automatically regulated in accord with the level of the disturbing noise.

(*c*) Echo suppressors with differential action (Cuban Company Document No. 33, C.C.I.F. 1935/36).

(*d*) Automatic or manual cutting out of echo suppressors on the land lines when two radio circuits are interconnected by means of a land line.

Question No. 10. Private Telegraph Service over Subscribers' Loops (Category A2). 3rd C.R. with collaboration of 6th C.R. and C.C.I.T.

Is it desirable to provide special toll office positions serving the circuits over which private telegraph transmission between subscribers can be given ?

What are the operating and maintenance regulations to be given to the central office personnel in order that such private telegraph transmission will not be interfered with and in order to eliminate any interference from the telegraph equipment into the telephone network ?

Note.—For purposes of information the procedure followed in Great Britain is as follows :—

Subscribers who desire to utilise telegraph service are given special numbers. The operators are able in this way to know that these subscribers are able to make use of telegraph facilities. The connections are established at a special position at the toll board and the operators have orders not to enter into the line except when the supervisory signals indicate that only one of the subscribers has hung up. Moreover, no message timing devices are connected to these lines.

Question No. 11. Modification of Psophometer Weighting Curve for Broadcast Circuits (Category A1). 3rd C.R. with collaboration of 4th and 5th C.R. and U.I.R. (Continuation of transmission Question No. 11 of 1935/1936.)

Is it advisable to modify the provisional " weighting " curve for filters in psophometers used on international circuits specially set up for music transmissions in order to adapt this curve to the technical conditions of these special circuits ? In the affirmative, what modifications are recommended ?

Note 1.—It is necessary in this study to take into consideration not only the filter network but also the indicating meter used in the psophometer for broadcast circuits, it being understood that both continuous and variable noises are being dealt with.

Note 2.—This study should be made by the C.C.I.F. in collaboration with the U.I.R. and the C.I.S.P.R. appointed by the International Electrotechnical Commissions to study similar questions concerning radio interference (see Report No. 2 of the C.I.S.P.R.).

Annex to Question No. 11.

It is desirable that the various Administrations and Operating Companies pursue the study of judgment tests as undertaken by the American Telephone and Telegraph Company regarding the relative disturbing effects of various frequencies on the reception of high quality broadcast transmission.

The technique used by the American Telephone and Telegraph Company for these tests is as follows :—

Each observer is seated in a room reproducing the acoustics of a normal quiet residential room and is asked to imagine himself listening to a broadcast programme. The programme furnished includes a small quantity of line noise which can be varied, and the observer is asked to vary this noise until it is just not sufficient to trouble his appreciation of the programme furnished to him.

Before each test the hearing of the observer is tested to determine whether or not it is normal. Especial attention is given to the ability of the observer to note the higher frequencies since the variations in hearing are more marked at the high frequencies than at low frequencies. In general the hearing of the observer used corresponded more with that for young people than for old since the latter were found to have a poor ear for this higher range of frequencies. The frequencies used covered a range of up to about 15 000 cycles. Observations were made, in this range, of pure tones, tones comprising a narrow band of frequencies, combinations of tones and distorted crosstalk.

The effect of these types of noises was studied for four types of broadcast programmes : high-quality orchestra music ; violin and piano ; jazz ; and finally, the human voice. It was found that the high-quality orchestra imposed the most severe restriction on noise and it is for this reason that the noise data corresponding to this class of music only was used in establishing the weighting curve for the psophometer.

Certain tests were made during the morning when the room noise was low in order to obtain some indication of the effect of room noise.

Question No. 12. Limits of Crosstalk (Category A2). 3rd C.R. (Continued from old Transmission Question No. 12 of 1935/1936.)

Should the provisional limit of 7.5 nepers or 65.1 decibels for the allowable near or far-end attenuation due to crosstalk between two complete wire circuits in the same cable, used for terminal traffic, be modified ? (See page 114.)

What should be the limit admitted for near or far-end crosstalk attenuation (*a*) between two complete two-wire circuits in the one cable (*b*) between a complete two-wire circuit and a complete four-wire circuit in the one cable ?

To decide this point it will be necessary to carry out tests in the method described in the Annex which follows, taking the following precautions :—

(1) Between the toll exchange and the subscriber, make use of circuits which simulate the conditions met with in the territory of the various Administrations for extension circuits normally connected to the toll circuits used in the tests.

(2) Make use of variations in volume which correspond to the actual conditions which exist in the territory of the various Administrations.

(3) Employ in the tests a comparatively large number of different operators for speaking and listening.

(4) Make use in the tests of variations of room noise and line noise similar to those usual in the countries concerned.

(5) Besides tests with figures, carry out similar tests, using a typical conversation as observed on the toll lines of the Administration concerned. In this case the criterion of secrecy would be whether one could correctly obtain by crosstalk four consecutive words in a short time (5 to 10 seconds approximately).

Question No. 12 bis. Measurement of Crosstalk (Category A1). 3rd C.R. in collaboration with 4th C.R. (Continued from Transmission Question No. 12 bis of 1935/1936.)

(*a*) What objective method is to be recommended for measuring crosstalk attenuation to replace voice and ear tests ? (See Annex I, II and III.)

(*b*) In place of considering only crosstalk attenuation, should consideration also be given to " crosstalk volume " which is that volume (measured under service conditions by means of a volume meter) of crosstalk produced on a telephone transmission circuit in one direction by the voice currents in adjacent circuits (or by adjacent circuit) ?

Note.—Crosstalk attenuation is an important factor in planning for telephone systems, in specifications, etc.

This crosstalk attenuation should be determined, from the tests, in such a way as to obtain all data necessary from the point of view of crosstalk between the various telephone systems. The measurement of crosstalk volume is a suitable method of determining that crosstalk troubles have been sufficiently reduced. It should be stated that, at the end of systems over which no useful signal is being sent, various kinds of parasitic noise can be observed. The following may be distinguished : (1) A basic noise due to current supply noises and induced noise ; (2) On this basic noise are superimposed isolated points due to crosstalk, clicks (selectors in automatic systems), ringing, telegraphic noises, etc.

Objective measurements of circuit noise should be completed by subjective observations with a telephone receiver in order to distinguish the various kinds of noise source and to establish, so far as possible, distribution curves of the various values of parasitic voltage.

(*c*) Should the crosstalk between two circuits, on which the frequency bands include or partially include the same frequencies, be characterised by a single value of crosstalk attenuation and if so, how should this crosstalk attenuation be defined and how should it be measured ?

Note.—In measurements between two telephone circuits, free from appreciable non-linear distortion, such as two ordinary telephone circuits, it is possible to express the crosstalk by a single figure if an objective measurement of crosstalk attenuation is made (see above under (*a*)).

It appears possible to characterise the crosstalk between two circuits whose frequency bands include wholly or partially the same frequencies, by using a suitable tone source (see Annex IV and V below).

(*d*) Should not consideration be given to a similar idea to that of the signal to noise ratio, when the parasitic currents are due to crosstalk ?

Note.—It would be possible when the parasitic currents are due to crosstalk to determine the signal to noise ratio by tracing curves of the useful signal voltage distribution and of the crosstalk voltage in accordance with the method given for signal to noise ratio on page 80 ; but it is first necessary to select the objective method of measuring crosstalk as mentioned above under (*a*).

Annex I to Question No. 12 bis.

Remarks of the A.E.G. Company on crosstalk measurements.

The A.E.G. Company have made tests on the measurement of crosstalk (linear and non-linear) with the oscillator producing a complex current described on p. 127 of Volume IV (English Edition p. 411) of the White Book.

It is usual to simulate speech by using a generator which gives almost the same Fourier spectrum as does speech from the terminals of a normal carbon microphone.

In the case of the complex tone oscillator used, where sequences of damped waves repeat themselves at short intervals, conditions are similar to those in the case of speech which is essentially composed of waves of this character. The frequency of the damped wave fixes the position of the principal harmonic. The phase of the various harmonics of the Fourier spectrum has hitherto been neglected, since it was not necessary to take it into account in measuring linear crosstalk. In linear systems the superposition law applies.

In carrier systems in which several conversations take place over the same line it may happen that in addition to linear crosstalk, non-linear crosstalk is produced. The harmonics and differential sounds penetrate adjacent circuits and are manifested in the form of crosstalk.

There is also a temptation to use the complex tone oscillator in place of speech also for measurements made on carrier systems. Tests have been carried out to discover the influence of the load of the complex tone oscillator on non-linear distortion (as a function of the amplitude).

If the form of the wave produced at the alternating voltage terminals of the complex tone oscillator under different loads is studied, damped waves are obtained, as shown in Figs. 1 and 2, which are repeated at regular periods. Fig. 1 shows the phemonena which occur when the complex tone oscillator had a 600 ohms load ; in Fig. 2 the load is 5 000 ohms. The damping rate is clearly shown. The greater the ohmic load the longer the time required for the phenomena to disappear. Figs. 1 and 2 were taken for the same effective value oscillograph current.

The maximum amplitude in Fig. 2 has fallen 25 per cent. as compared with Fig. 1. If a smoothing device consisting of a transformer with a discharge lamp on the secondary side is connected in parallel at the output of the complex tone oscillator, the oscillogram shown in Fig. 2 will be obtained when the system has been adjusted to the same effective value. The damped wave series then undergoes considerable modification. The voltage increases until the discharge value of the lamp is reached, when it again decreases. The damped wave shows several points where the maximum amplitude is of the same value as when the complex tone oscillator was loaded to 20 000 ohms.

Such waves have been analysed by the Grützmacher process of harmonic analysis. The wave in Fig. 1 corresponds to the Fourier spectrum given in Fig. 4, where the frequencies are grouped around 800 p : s. The fundamental frequency, around 160 p : s, is also clearly visible. If the load is increased to 5 000 ohms the spectrum shown on Fig. 5 will be obtained, corresponding to the wave on Fig. 2. Seeing that the oscillation is less severely damped, the frequencies around 800 p : s are more pronounced. The Fourier spectrum corresponding to the complex wave oscillator loaded with the smoothing device (Fig. 6) has an entirely different appearance. The greater number of harmonics are situated around 160 p : s whilst the amplitudes around 800 p : s have decreased. On the other hand, the higher harmonics up to 4 000 p : s are more frequent than in the case of an oscillator not terminated by a smoothing device. If use is made, in measuring crosstalk on carrier current systems, of a complex tone oscillator with a smoothing device, other results than those obtained with an oscillator having no smoothing device, must be expected in consequence of the different aspect of the Fourier spectra. With regard to the linear crosstalk in two-way carrier telephone systems, which is caused by the attenuation effect of the filters, the smoothing device has the effect of reducing the

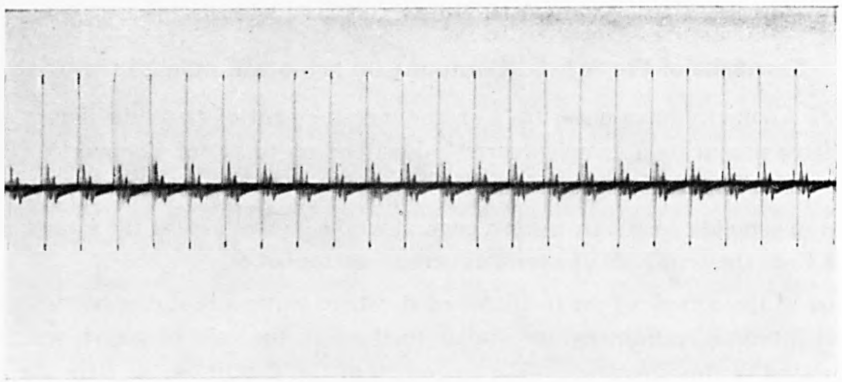


FIG. 1. Oscillogram of Complex Tone Oscillator (with 600-ohm load).

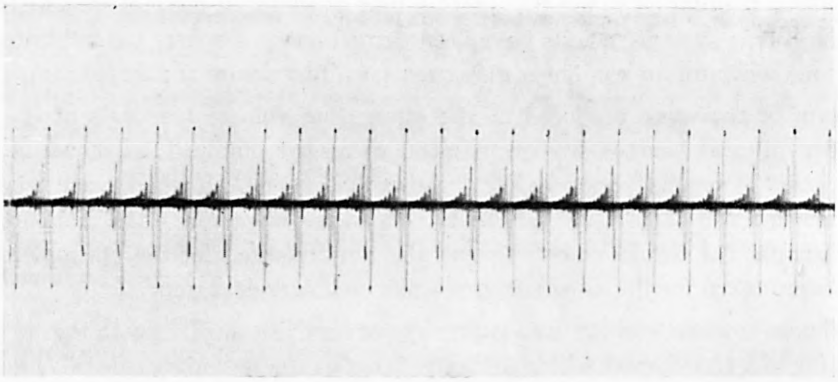


FIG. 2. Oscillogram of Complex Tone Oscillator (with 5 000-ohm load).

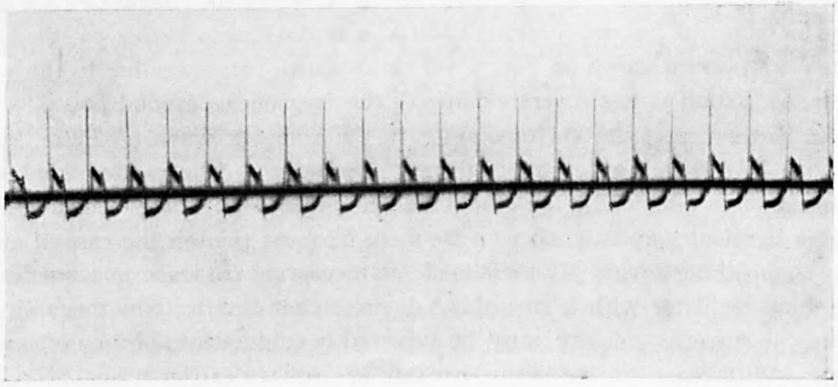


FIG. 3. Oscillogram of Complex Tone Oscillator (with smoothing device).

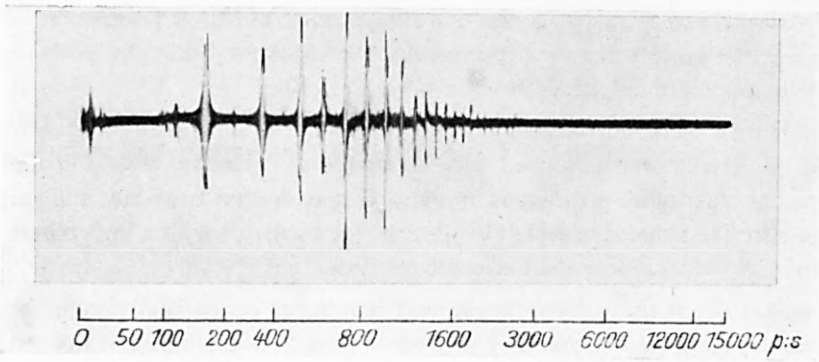


FIG. 4. Harmonic analysis of the Complex Tone Oscillator (with load of 600 ohms).

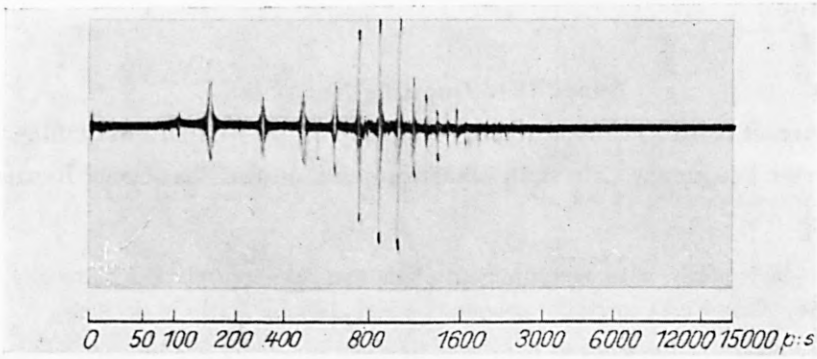


FIG. 5. Harmonic analysis of the Complex Tone Oscillator (with load of 5 000 ohms).

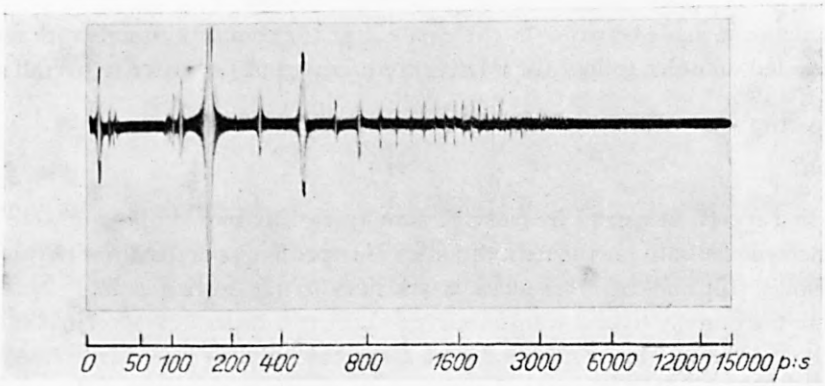


FIG. 6. Harmonic analysis of the Complex Tone Oscillator (with smoothing device).

attenuation of crosstalk current in consequence of the presence of higher harmonics. The non-linear crosstalk has almost the same value as in the case of the oscillator loaded to 5 000 ohms by reason of the fact that the maximum amplitude reaches the same value.

If the complex tone oscillator is considered to be a suitable substitute for speech, the contrary is the case when this oscillator is equipped with a smoothing device by reason of the fact that the Fourier spectrum has then quite a different aspect. If it is desired to reduce the amplitude whilst keeping the same effective value it is preferable to load the oscillator with a high ohmic resistance, as shown by the study of the results of the harmonic analysis.

In measurements of crosstalk, both linear and non-linear on carrier systems, it is necessary, therefore, to obtain a substitute for speech, which would have the same range of frequency and almost the same spectrum as speech (taking phase relationship into account).

Comparison has been made between the results of measurements made with a complex tone oscillator and those made with a special gramophone record on which was recorded the noise made by 15 people speaking at once. It was found that the variations in the amplitude of the non-linear crosstalk on a carrier system are different when this record is used from those when the complex tone oscillator is employed. For instance, the non-linear crosstalk between circuits on a carrier system increases with the complex tone oscillator volume, but decreases with the volume when the gramophone speech record is used.

Annex II to Question No. 12 bis.

Extract from Technical Report No. 7896 of the British Post Office.

Carrier Frequency Crosstalk Measurements on the East Coast Routes.

Scope of Work.

This report deals solely with measurements, analyses, and correlation of results of Carrier-to-Carrier Frequency Near-End Crosstalk expressed as Signal/Noise Ratio in decibels.

The primary object of the work in hand was to select quads for use by carrier telephone circuits between London and the North.

A secondary object was to discover, if possible, any laws that might govern the existence, distribution and addition of crosstalk at high frequencies in a cable whose low frequency performance is satisfactory. This section of the work is divided into two parts, viz., single tone and speech measurements. A general correlation between the two is attempted.

Another secondary object is to attempt to put the primary objective on a simple basis for future tests of the same type.

Again, distinction is made between the cable pairs, and the complete circuits with repeater station equipment connected, in order to find the relative contribution of the latter to overall crosstalk.

Method of Testing.

(*a*) Speech.

All tests using speech at carrier frequencies were applied by means of a complete model carrier set lined up in accordance with practical conditions. The speech was derived from a " robot speaker " apparatus at Dollis Hill and fed over spare trunk lines to the testing point. This input to the modulator before the dummy hybrid transformer was kept to a reasonable level and called zero level. The filtered sideband output (lower sideband from a suppressed 5 800 p : s carrier frequency) was fed into a repeater whose output to " disturbing pair " was 10 db above zero level. The sideband crosstalk from a " disturbed pair " was passed through a repeater to the filters and demodulator, whose output,

after a dummy hybrid transformer, was adjusted to correspond to zero level when the attenuation between the disturbing and disturbed pair connections was equal to the attenuation of the section of cable faced by the equipment. Thus the difference in level between the demodulator output (intelligible speech) and the zero level point was a direct measure of the signal/noise ratio corresponding to any attenuation placed between the disturbing and disturbed pair connections.

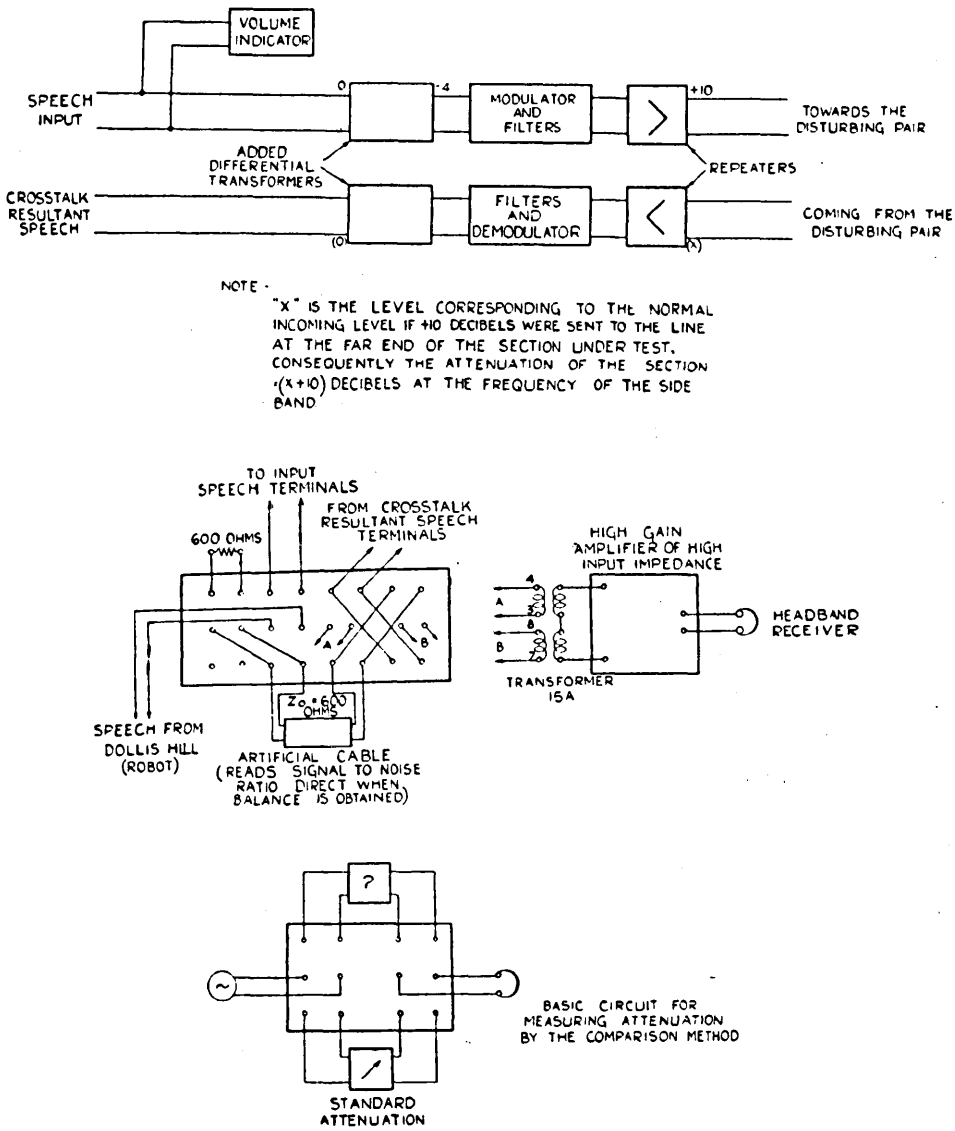


FIG. 1. Crosstalk Measurement at Carrier. Frequency Schematic Arrangement of Apparatus.

The estimation of level difference was made aurally by comparison against artificial cable, but certain precautions were found necessary in doing this (see Fig. 1). In order to obtain a level of signal in the headgear receivers well above that of external noises, a high-gain amplifier (35 to 40 db) was used to raise the sensitivity of the receivers. Now when listening on the line there is always a background of noise which naturally disappears on the artificial cable side of the balancing switch. This can cause a very serious error indeed in equating the loudness of the crosstalk to that on the standard attenuator. While it is impossible to remove noise from the line, it is possible to introduce

exactly the same amount of noise on the comparison side, thus preventing desensitisation of the listeners' ears on one side only. The switching arrangement shown in Fig. 1 was devised to enable the observer to hear continuously the total noise from both sides of the comparison switch, while listening alternately to the standard and test signals. As long as the amplifier input impedance is high compared with 2 400 ohms over the frequency range 200-3 000 p : s the switch provides correct impedance matching in every necessary direction.

Other applications have since been found for this device.

The word " speech " herein in connection with crosstalk refers to speech via a carrier set, i.e. sideband frequencies.

(*b*) **Tone.**

In tests on cable pairs without station equipment, 5 000 p : s tone from an oscillator was fed to the " disturbing pair " and the amount of crosstalk assessed by the potentiometer method using a 100 db amplifier with rectifier and galvanometer. Here again, line noise (mostly babble from working pairs) made measurement impossible until the amplifier was strictly tuned to 5 000 p : s although even then an unsteadiness was sometimes occasioned by components of the noise passing at the tuned frequency.

In tests on circuits including station apparatus, the arrangement described for speech was used with an input from an 800 p : s oscillator in place of speech, i.e. using a sideband frequency of 5 000 p : s as before. A greater sense of satisfaction was felt in making these aural measurements because it was known that the correct sound only was being balanced, while in the visual case doubt must always exist in this respect. However, neither method is of great value in view of the results obtained with single tones.

It appears that no law (except (i) random effect with (ii) probable reduction of signal/noise ratio with extra length) rules the results. A large number of addition-effect results were studied with the addition of the Fenny-Leicester section to the London-Fenny section. In this case various changes were noted, ranging from an improvement of 5 db to a reduction by 8 db, the average of all changes being practically zero.

The underlying theory appears to be that for a single tone the crosstalk value must be regarded as a vector quantity, having phase as well as magnitude. The magnitude in terms of signal/noise ratio is unaltered by observing a distant crosstalk from one end (for the repeater gains cancel the attenuations of the intervening cable sections). Now the superimposed crosstalk effects from two sections when added are equally likely to add to or to subtract from each other, for it is an equal chance whether the phase difference is $> \pm \frac{\pi}{2}$ or $< \pm \frac{\pi}{2}$, and this is borne out in the two-section results mentioned. Similarly, for an infinite number of sections the resultant must be a complete cancellation of all crosstalk because for every value occurring there will be another equal value at π phase-difference. With a finite number of sections greater than two and with a complex mixture of tones (e.g. speech), the problem is far too involved to admit of analysis by theory or experiment, except that among a very large number of cable pairs the total degradation of all of them is most probably zero. Single cases are governed by chance only.

Similarly, it has been shown that small elements of crosstalk in one long cable section itself add in a random manner for similar reasons. The relation between the crosstalk measured at the two ends of the single section, Fenny to Leicester, is shown by the target diagram, Fig. 2. Taking the Leicester end alone, if the distribution or density of the readings along the crosstalk scale is governed by pure chance the law of that distribution is the Gauss Error law, which can be derived from the readings and fits the case very well. Similarly the readings at Fenny can be shown to be distributed by the same law of chance with a slight change of constants. Now if there be no other relation than

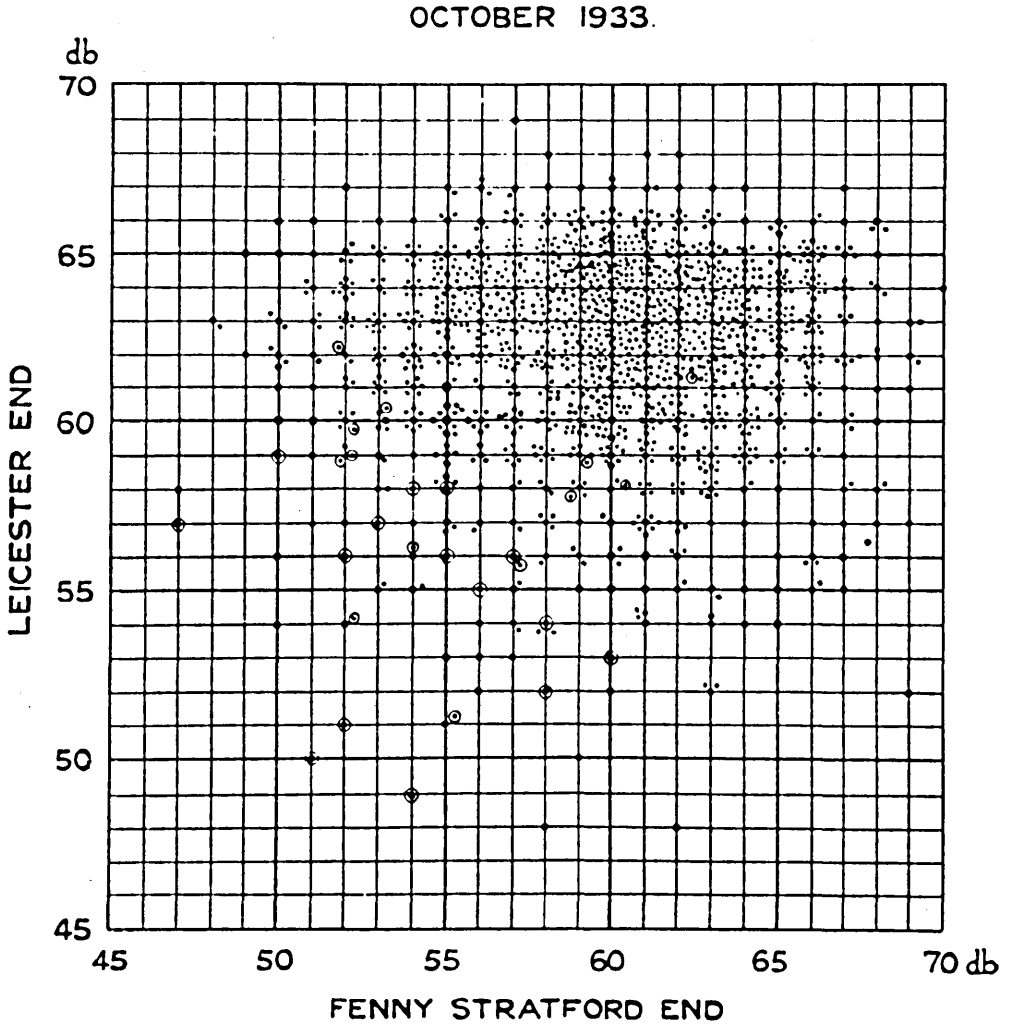


FIG. 2. Target diagram connecting carrier crosstalk at the two ends of a long cable section.

Near end crosstalk; speech on 5 800 p:s carrier (lower sideband) BXE cable pairs 105 and 106 reloaded for carrier working on the section Fenny–Leicester.

Points showing crosstalk between the pairs of the same quad are shown encircled. 1 512 Points.

pure chance connecting the results at the two ends of the same pairs, the target diagram connecting the two ends must be governed by contours which represent the product of the chances of a value occurring at each of the ends. These contours have been derived and plotted (see Fig. 3), and agree substantially with the observed results.

From this law of chance the important conclusion is drawn that if N pairs are to be rejected on the basis of measurements of bad crosstalk at one end of an electrically long cable, these N pairs will probably appear satisfactory at the other end, but about a further N pairs will have to be rejected on account of their performance at the second end.

In listening to some of the crosstalk on great lengths, an " echo " effect was noticed, and this is attributed to " lumped " bad elements of crosstalk near the beginning and end of the cable, the time of propagation on both disturbing and disturbed pairs separating the times of arrival of the concentrated returns of the voice. In a few cases a multiple echo was observed.

An annoying feature of the results obtained is that for long circuits crosstalk results for both

speech and tone showed variations with time. In some cases the readings could be observed to vary from minute to minute, and in nearly all cases a correct repetition of any reading after a few days was impossible. Variations were noted in both directions and the algebraic sum of the improvements and degradations was under 1 db.

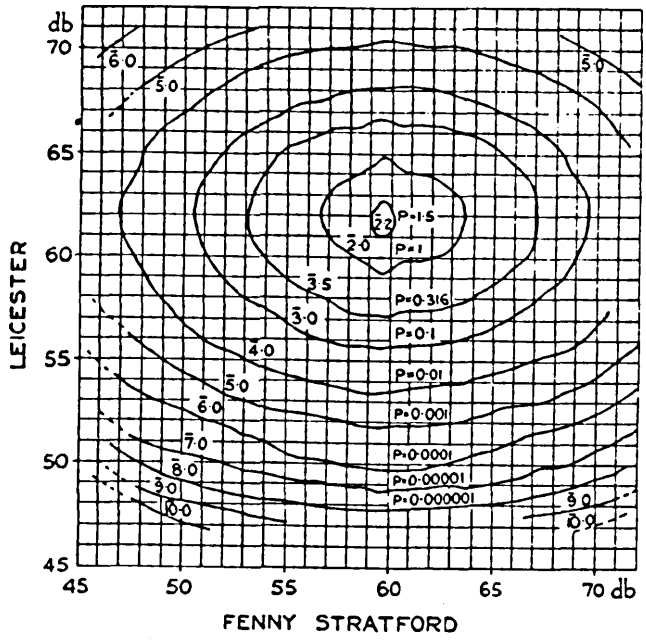


FIG. 3. Distribution of the points shown on FIG. 2 assuming pure random law.

Near end speech crosstalk (signal to noise ratio for carrier tests on Fenny-Leicester section). Target probability contours based on pure chance connecting the crosstalks at the two ends.

" P = 1 " means that the chances are that 1 per cent. of all the observations fall into any square passed through by the P = 1 line.

The reason for this was discovered, but as the methods of measurement simulated the conditions of practical use of the circuits, the variation effect was ignored. Bad crosstalk on a circuit, which tested good, would probably be short-lived if it ever occurred at all, and the lower limit of crosstalk is in any case not at all likely to be more than one or two db below values passed as satisfactory for service. The bad values on some pairs at Edinburgh (which have caused the rejection of these pairs for carrier working) are due to the Jedburgh-Edinburgh cable section, and it is therefore contended that the accepted pairs at Edinburgh will never vary down to anything approaching this low limit.

The reason for variation of the crosstalk values with time is elucidated by curves of Figs. 4 and 5, which show the variation with frequency over a small part of the band. It is evident from the curve that the crosstalk value with tone is highly critical to slight frequency changes. Thus, if the carrier frequency were to drift a few p : s (20 p : s is regarded as permissible from ordinary quality of speech considerations) the results obtained would be very different. Again, when testing with speech, the ear must take account of the prominent tones in assessing loudness, and if the rotating drum of the speech robot were to vary in speed slightly, even with no drift of carrier frequency, a change of apparent crosstalk value would probably occur. In some cases where variations were noticed the robot was substituted by a living voice via a telephone instrument, and it was almost impossible to assess the value of crosstalk owing to fluctuations of pitch in the prominent tones of the speaker's voice.

When a crosstalk value is not varying during a short period of observation, different observers agree very closely in the assessment of the signal/noise ratio.

With so much indefiniteness, it was considered justifiable to do as has always been done with ordinary speech, i.e. to take readings on all circuits concerned at one sitting and accept the results as

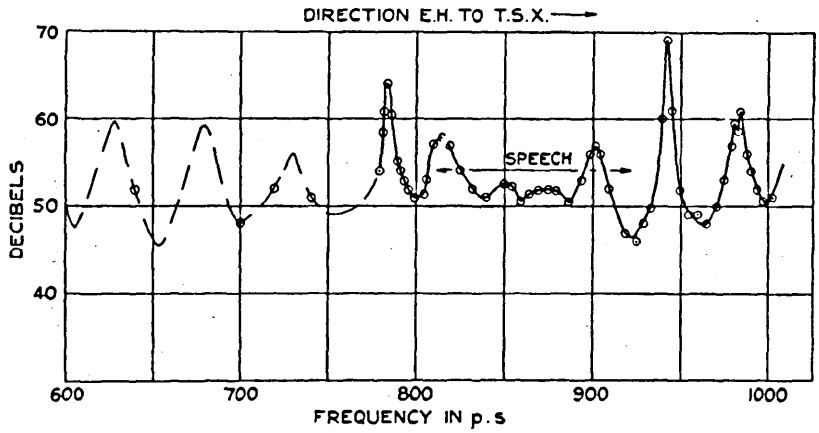


FIG. 4. Crosstalk characteristic as a function of frequency.

Crosstalk measured on a carrier telephone system using a voice frequency sinusoidal current. Pairs 149/158. At E.H. Jedburgh repeaters corrected.

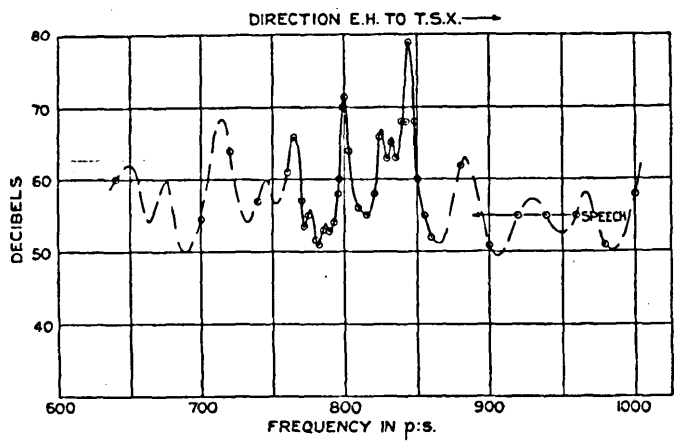


FIG. 5. Crosstalk characteristic as a function of frequency.

Crosstalk measured as in Fig. 4 on a carrier telephone system using a voice frequency sinusoidal current. Pairs 150/157. At E.H. Jedburgh repeaters corrected.

correct for the selection of working circuits, since we know that the lowest ebb of the signal/noise ratio will in most cases be tolerable, and in all cases not wander more than a very few db below the acceptance limit, which has been fixed at 52 db for reasons discussed below.

Acceptance Limit of Signal/Noise Ratio.

It was evident from early results on the Fenny Stratford-Leicester length that the number of quads available varies steeply with acceptance limit. For example, we see from Fig. 6 that to reject all cases giving rise to crosstalk of 56 db and over gives 9 circuits, while rejection at 52 db and over gives 19 circuits.

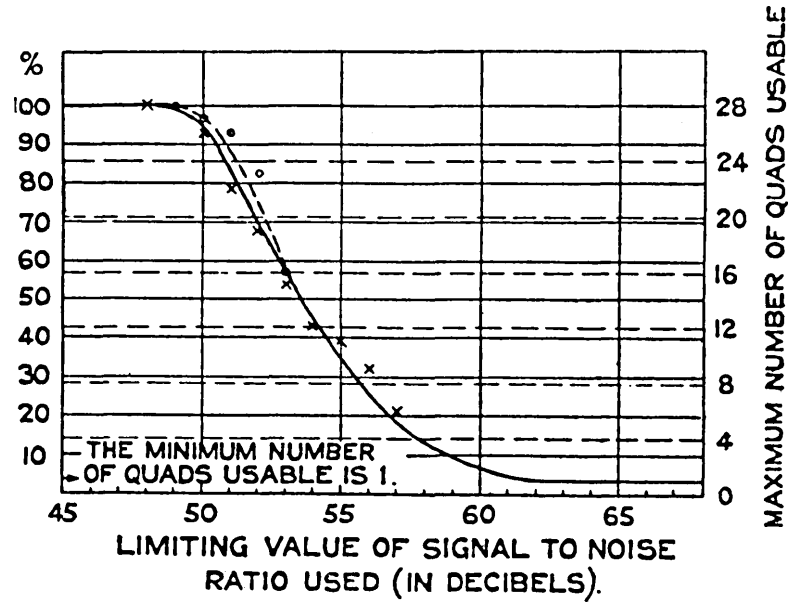


FIG. 6. Measurement of Crosstalk made at carrier frequency on the East Coast cable on number of quads available for carrier telephony (between Fenny and Leicester).

x represents the maximum number of quads available with the existing go and return allocation.

A probability curve of form $y = \frac{h}{\sqrt{\pi}} e^{-h^2 x^2}$ is the one which agrees most closely with the full line curve.

o represents the maximum number of quads available where advantage can be gained by interchanging existing go and return within quad. Dotted line is best fit by probability curve.

The equation for the full line curve is :—

$$\text{No. of quads} = 1 + 27\, e^{-0.0235\,(\text{db} - 48)^2}$$

$$= 1 + \frac{27}{\text{Antilog}_{10}\left\{0.0102\,(\text{db} - 48)^2\right\}}$$

The equation for the dotted line curve is :—

$$\text{No. of quads} = 1 + 27\, e^{-0.036\,(\text{db} - 49)^2}$$

$$= 1 + \frac{27}{\text{Antilog}_{10}\left\{0.0156\,(\text{db} - 49)^2\right\}}$$

All the measurements described in this report have been made on near end crosstalk, experience having proved that in cables which have been thoroughly balanced for audio frequencies, far end crosstalk is always less troublesome than near end.

Annex III to Question No. 12 bis.

Observations of the American Telephone and Telegraph Company on the Methods to be employed for Characterising Crosstalk between two Telephone Channels.

As regards crosstalk between programme and message circuits, we have found it both convenient and practicable to set a single value for the crosstalk coupling. This value is in terms of the crosstalk coupling at 1 000 cycles per second. However, in establishing the limiting magnitude, consideration is given to the somewhat wider frequency band of the programme circuit, and the crosstalk coupling value is adjusted correspondingly with respect to what its magnitude would be if two message circuits were involved. The crosstalk coupling between a programme and message circuit may be measured,

using the visual indicator apparatus described in our memorandum of August 8, 1934, or using a rhythmic oscillator having an 830-1 230 cycle per second frequency band together with an ear balance crosstalk measuring set.

As regards the crosstalk between channels of high frequency open-wire carrier systems which are only partially within the same range, it is the practice to consider it as noise. Experience has confirmed the reasonableness of the method since this type of cross-induction is manifested in the form of noise and not as intelligible crosstalk. The magnitude of this effect would be given in terms of db above reference noise. Theoretically such crosstalk can be measured by energising the disturbing carrier channel at its voice frequency terminals by a rhythmic oscillator having a frequency band of 300-2 700 cycles per second, and measuring the noise at the voice frequency output terminals of the disturbed channel with an ordinary circuit noise meter. Pending the general introduction throughout the Bell System of such a rhythmic oscillator, a practical expedient involves the use of a far-end voice frequency crosstalk coupling ear measurement.

This crosstalk coupling method consists in selecting three carrier frequencies which are common to the frequency range of the two channels being measured. For each of the two channels to be tested three unmodulated voice frequencies (at the input, voice frequency terminals of the channels), which, when modulated by one or the other of the two carrier frequencies, produce a frequency in the overlapping range, are selected. A variable frequency oscillator is connected to the voice frequency input of the disturbing channel at one end. The oscillator is adjusted to one of the three frequencies selected for this channel. The disturbed channel voice frequency terminal is terminated in a resistance corresponding to the characteristic impedance of the channel. At the distant end the " disturbed-circuit " terminals of the ear-balance crosstalk meter are connected to the voice frequency output of the disturbed carrier channel. The voice frequency output of the disturbing carrier channel at this end is terminated in a resistance corresponding to the characteristic impedance of the channel. A variable frequency oscillator is connected to the " disturbing-circuit " terminals of the ear-balance crosstalk meter. This oscillator is adjusted to the frequency which will appear at the output terminals of the disturbed carrier channel through cross-induction from the particular frequency applied at the input of the disturbing channel. The outputs of the oscillators at both the sending and receiving ends are made of the same magnitude. The crosstalk coupling is then measured in the usual manner by comparing the tone on the disturbed channel arising from cross-induction to that supplied by the oscillator connected to the " disturbing-circuit " terminals of the crosstalk meter. The above process is repeated, using the other two voice frequencies selected for each of the two channels involved. The three values of crosstalk coupling thus obtained are averaged to obtain a value which is representative of the crosstalk coupling between the two channels.

As noted above, crosstalk between channels having frequency bands only partially in the same range is considered in the Bell System from the standpoint of noise. Using the crosstalk coupling values so determined in conjunction with data indicating the magnitude of talker volumes (expressed in db above reference noise) which may be present on a toll circuit, values may be obtained indicating the magnitude of the noise on a particular channel caused by such crosstalk.

Annex IV to Question No. 12 bis.

Method of Testing used in Germany for Determining the Admissible Crosstalk between two Complete Circuits.

The tests described below by Dr. H. F. Mayer have been made with the object of determining the limiting value of crosstalk attenuation (intelligible crosstalk) admissible between two complete circuits. Let us consider two circuits (Fig. 1) adjusted to an overall attenuation of 0.80 neper (overall attenuation

of the circuits when used for terminal traffic) and suppose that the talking subscriber A is connected to the disturbing circuit

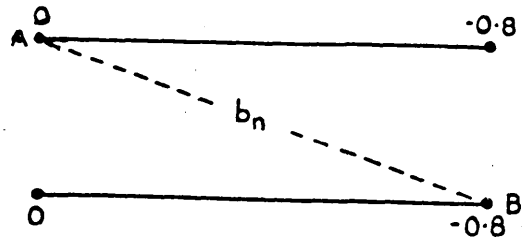


FIG. 1.

and that the listening subscriber B is connected to the disturbed circuit, these two circuits having an adjustable coupling between them characterised by an attenuation *bn*. The test is first made with no circuit noise and no room noise, and curve 1 Fig. 2 is obtained.

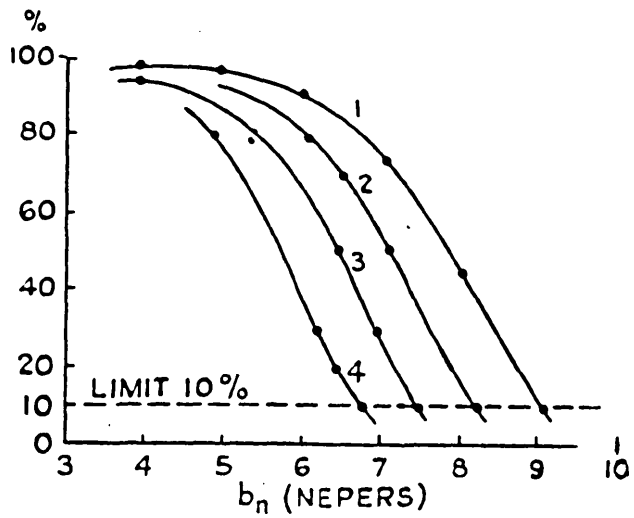


FIG. 2.

The same test is repeated after circuit noise and room noise have been introduced and curves 2, 3 and 4 are obtained, which are approximately parallel to curve 1.

It may therefore be considered that secrecy of conversation is sufficiently assured if 10 per cent. only of the figures transmitted are understood by means of crosstalk.

Thus it may be seen from the preceding curves that, in the absence of all circuit and room noise, a far- or near-end crosstalk attenuation at least equal to 9 nepers is necessary.

If the circuit noise corresponds to a psophometric E.M.F. equal to the admissible limit of 5 mW, and if the room noise reaches a value of, say, 45 phons, the curve under these conditions indicates that a near- or far-end crosstalk attenuation of at least 7.5 nepers is required if 10 per cent. only of the figures spoken are to be understood by means of crosstalk.

This corresponds to a signal/noise ratio at the end of the disturbed circuit of :

$$7.5 - 0.80 = 6.7 \text{ nepers or } 58 \text{ decibels.}$$

It should be noted that experience has shown that isolated figures are more easily understood by means of crosstalk than are words, so that the above would hold good for any conversation.

Annex V to Question No. 12 bis.

Proposals of the American Telephone and Telegraph Company concerning Allowable Crosstalk Attenuation between two Overall Circuits.

Crosstalk.

As is known, distinction is made between near-end and far-end crosstalk.

From a general standpoint, the crosstalk volume should be so low that no subscriber can understand what any other subscriber says on another circuit. This is desirable from the standpoint of preserving secrecy and also from the standpoint of the annoyance which may be caused by unwanted speech currents.

The assumed limitation on circuits from a crosstalk volume standpoint is that a subscriber shall have only a very small chance of hearing understandable crosstalk. This chance is determined by the distributions of the crosstalk couplings, the room noise and circuit noise, the terminal losses, the talker volumes on other circuits, and the natures of the talkers and listeners. Present data indicate that the chance of a subscriber hearing understandable crosstalk is very small in the case of two-wire cable circuits if the crosstalk conditions are such that there is not more than about one chance in 100 that any one or more of the couplings between the disturbed circuit and the various disturbing circuits shall exceed 1 000 crosstalk units (60 db loss). Further investigations of this matter and other questions in connection with crosstalk are being made.

Crosstalk in cable circuits may be either within-quad or between-quad crosstalk. Crosstalk within the quad may be phantom-to-side, side-to-phantom or side-to-side, and may be divided into office crosstalk and cable crosstalk.* The office crosstalk is due to capacitance unbalance in the office wiring and to repeating coils, repeaters, and other office apparatus.

The crosstalk in the cable outside the office is due to loading coil unbalance, series resistance unbalance, and capacitance unbalance. Crosstalk between different quads is normally due almost entirely to capacitance unbalance.

When the complete repeater sections have been installed, cross-connection of the circuits at certain repeater points is generally used to reduce the overall crosstalk between circuits. In the case of two-wire circuits, this cross-connection consists of breaking up all phantom-to-side and side-to-side combinations in a given quad at each repeater station, and the system is designed to make it improbable that any two of these circuits will ever be in the same quad again. In the case of four-wire circuits, this cross-connection is resorted to only at the ends of each pilot wire regulator section.

The method of computing the crosstalk limitations of a given cable circuit is as follows: Determine the r.m.s. (root mean square) within-quad crosstalk coupling per loading section by adding together the r.m.s. crosstalk coupling due to capacitance unbalance, resistance unbalance and loading coil unbalance as the r.s.s. (root sum square) of the parts expressed in crosstalk units. From this, get the r.m.s. unamplified crosstalk coupling per repeater section by properly attenuating the crosstalk coupling from each loading section. The attenuation in each case equals the loss from the output of the repeater transmitting into the disturbing circuit (in that repeater section) to the point of crosstalk coupling plus the loss from this point to the input of the repeater receiving from the disturbed circuit. The total r.m.s. within-quad crosstalk coupling per repeater section is the r.s.s. of the crosstalk coupling from each of the loading sections and from the office. The between-quad crosstalk coupling per repeater section is obtained in a similar manner.

In the case of near-end crosstalk on two-wire circuits, the unamplified crosstalk coupling so

* Specific values of the various sources of crosstalk are given in a paper entitled "Long Distance Telephone Circuits in Cable," by A. B. Clark and H. S. Osborne, *B.S.T.J.*, Vol. XI, October, 1932.

determined is then amplified or attenuated by the gains or losses from the transmitting terminal of the disturbing circuit to the repeater section in question, and then to the receiving terminal of the disturbed circuit. Next, the r.s.s. of this crosstalk coupling and the between-quad crosstalk coupling from the same disturbing circuit in other repeater sections is obtained. The probability of this total crosstalk coupling exceeding 1 000 units is then determined, making due allowance for the variations of net loss. For near-end crosstalk, in a circuit without variations, the probability that 1 000 units of crosstalk will be exceeded when the total r.m.s. crosstalk coupling* is "x" crosstalk units is approximately

$$Pn = e\text{-}k^2 \text{ where } k = \frac{1000}{x}$$

An approximate method of allowing for circuit variations is to consider a circuit with variations equivalent to a circuit without variations with a net loss smaller than the average net loss of the former circuit by one-quarter of the variations ; i.e. if the variations are $\pm$V db, the value of k to be used in the above formula is

$$k = \frac{1000}{x} \, 10^{-V/80}$$

Fig. 1 shows the value of Pn plotted against k.

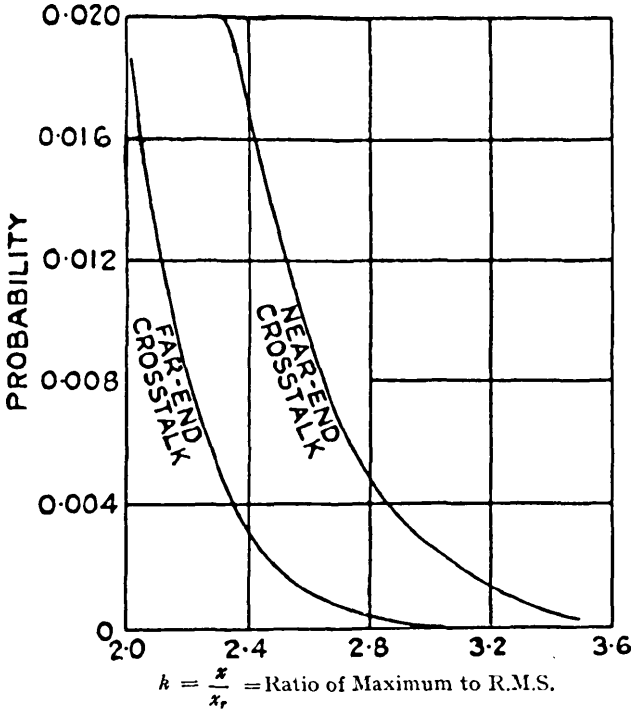


FIG. 1. Probability of exceeding a maximum of x units of crosstalk when the quadratic crosstalk coupling is x units on the crosstalk meter.

When these probabilities have been determined for all circuits having a similar within-quad exposure to the circuit under consideration, the total probability of the crosstalk coupling exceeding 1 000 units from any circuit may be determined and is approximately the sum of the probabilities of excessive crosstalk coupling from each of the disturbing circuits. (The probability of excessive crosstalk from circuits not having within-quad exposures is considered negligible.) When this probability is .01, the circuit is considered just satisfactory from a crosstalk standpoint.

* The ratio of the average near-end crosstalk to the r.m.s near-end crosstalk is about $\sqrt{\pi}/2$. The similar ratio for far-end crosstalk is $\sqrt{2}/\sqrt{\pi}$.

Far-end crosstalk coupling is computed in a similar manner, using the probability relations applying to far-end crosstalk and four-wire circuits, which are somewhat different from those applying to near-end crosstalk and two-wire circuits. In this case, the probability of exceeding 1 000 units of crosstalk when the r.m.s. total crosstalk is " x " units is approximately

$$P_f = 1 - \frac{2}{\sqrt{\pi}} \int_0^{k/\sqrt{2}} e^{-t^2} dt, \text{ where } k = \frac{1\,000}{x}$$

or with variations of $\pm V$ db,

$$k = \frac{1\,000}{x}\, 10^{-V/80}$$

Fig. 1 shows P_f plotted against k.

Relation between Crosstalk Coupling and chance of Intelligible Crosstalk.

Our memorandum of September 5, 1933, recommended that a series of tests be undertaken by the several Administrations in order that a relation may be determined between various assumed values of crosstalk coupling and the precentage chance of hearing intelligible crosstalk under specified conditions. Our experience has indicated that such tests as are necessary to establish such a relation cannot be carried out in a single laboratory if they are to be representative of plant and service conditions in all of the member Administrations.

The first of our recommendations was to the effect " that statistical data be obtained by the several Administrations regarding the reactions of a large number of observers to various values of crosstalk volume under controlled and varying conditions of room and circuit noise and using specified types of subscriber instruments at both the sending and receiving ends of toll connections. From such data the percentage of observers who consider crosstalk volume of a particular value intelligible under these specified conditions may be determined." A certain amount of such statistical data have been obtained in the Bell System. While it is only applicable to Bell System plant and service conditions, it is believed a somewhat similar procedure might usefully be followed in the various member Administrations.

The testing circuit used consisted of arrangements for bridging on to four four-wire telephone cable toll circuits in actual service in such a manner as to only get the near-end talker. These four bridging circuits were extended by cable pairs to a special laboratory, and a key arrangement therein whereby any one of the four circuits could be connected to the observing circuit. An amplifier and associated attenuator and volume indicator were provided in the observing circuit so that the volume from any one of the four toll circuits could be varied at will.

The observing circuit consisted of a subscriber loop representative of Bell System plant, and served by a standard battery supply cord circuit consisting of the usual repeating coil and associated battery supply circuit which was energised during the tests. At the end of the subscriber loop adjacent to the subscriber instruments, arrangements were provided for bridging on a circuit supplying the line noise. The line noise was supplied by a phonograph and associated amplifier so that its magnitude could be varied at will. The subscriber loop was terminated in a sound-proof booth in which the room noise could be varied in volume through a relatively wide range. The room noise was supplied to the booth by means of a phonograph and associated amplifier-loudspeaker. Switching arrangements were provided in the booth for connecting the various types of subscriber instruments as are used in the Bell System. Timing arrangements were also provided in connection with the general set-up which permitted the observer to listen only for a definite length of time. The length of this interval was established by analysing the length of conversations carried on on circuits in the Bell System and determining the average length of a momentary lull in the conversation on a telephone connection and the periods when only one of the parties is connected to the circuit. In our tests a seven-second interval was used, although other intervals were tried. These latter did not indicate any widely different results.

There was also bridged on the circuit at the input to the subscriber loop an arrangement which permitted another observer to monitor on the circuit. This observer, known as the monitoring observer, was placed in a separate room from the regular observer, and arrangements were provided to supply at all times a constant volume to the monitoring observer so that he would always hear the conversation on the circuit. The function of this monitoring observer was to record the conversation which was being supplied to the regular observer in the sound-proof booth.

The testing procedure was as follows : A particular circuit was selected for supplying the crosstalk volume. The crosstalk volume from this circuit was adjusted to a definite value and supplied to both the regular observer and the monitoring observer for a period of seven seconds. During this time the monitoring observer recorded the conversation on the circuits. At the end of the seven-second interval the regular observer was requested to repeat back over this circuit the conversation which he heard. This was also recorded by the monitoring observer directly under the conversation which he, the monitoring observer, had heard on this circuit. The observer was graded as hearing intelligible crosstalk if he understood four consecutive words correctly in the seven-second interval. In this connection the conversation recorded by the monitoring observer was used as a guide in determining the grade. The above testing process was repeated for various other values of crosstalk volume.

In the tests, an attempt was made to supply the crosstalk volume by using specially selected talkers, but it was found that the results obtained were *not* indicative of actual service conditions because of the fact that the specially selected talkers were more easily understood than the talkers selected at random from one of the four circuits.

A volume range varying from 78 db below reference volume to 10 db below reference volume was used in the tests in order to get a satisfactory distribution curve for the various observers. This volume range was supplied to each observer in steps of 4 db. The tests indicated that for conditions in the Bell System at least 75 observers (both male and female) should be used for each testing condition. Concerning the question of line and room noise, it would seem that a range of values typical of individual conditions in the member Administrations should also be included in the tests. The number of circuits used for supplying the crosstalk volume was, as already noted, four. The reason for selecting more than one circuit was to expedite the tests by providing for the ready availability of a greater number of talkers.

With the data obtained in accordance with the above tests, supplemented by crosstalk coupling measurements of the particular toll plant on which the above data are obtained, it should be practicable to determine a relation between various values of crosstalk coupling and the percentage chance of hearing intelligible crosstalk under specified conditions. It is, of course, necessary in applying such data to a given case, to determine distribution curves of the volume delivered to each end of the telephone line in the case under consideration, as one of the specified conditions.

Crosstalk Volume Measuring Apparatus.

The arrangement of apparatus now used in the Bell System for measuring crosstalk volume is generally similar to the volume indicator whose recommended characteristics are given on page 263 of the White Book, Volume IV. It includes, however :

1. A frequency weighting network, similar to that used in the psophometer (an instrument for the objective measurement of noise voltage), having a characteristic in conformity with the C.C.I.F. Recommendations.
2. An amplifier providing sufficient gain to permit reading the relatively small crosstalk volumes.

The crosstalk volume indicator is calibrated in terms of db above reference noise (reference noise being that noise which gives the same reading as 1 micro-microwatt in 600 ohms at a frequency of

1 000 cycles) and the gain of the apparatus is such that values of crosstalk volume as low as approximately 15 db above reference noise may be measured. A monitoring arrangement is provided which permits monitoring at the time of measurement and, therefore, the disturbing sounds may be identified as crosstalk or noise.

In making crosstalk volume measurements, the gain of the amplifier is adjusted until its output level is within the range of the " volume indicator " potentiometer, and then the " volume indicator " is read in the same manner as for measurements of speech volume. If one type of disturbance (noise or crosstalk) predominates, the visual indicator meter reading will be mainly determined by this type. If, however, both the noise and the crosstalk disturbances have about the same magnitude, the reading obtained with both present will be the composite reading, and not necessarily representative of either. In such cases an approximate reading of crosstalk volume may be obtained when the noise is steady by making two measurements, one of the noise alone and one of the combined crosstalk and noise.

Overall crosstalk volume measurements may be made from the toll switchboard without taking the circuits under test out of service. In such measurements, the disturbing sources are those set up by the various talkers involved in the telephone conversations on the adjacent circuits, and the measurements are usually made during periods of reasonably heavy traffic load. Measurements during such periods provide results which are representative of the more unfavourable crosstalk conditions and, in addition, the method makes it unnecessary to specially energise one or more disturbing circuits for the test.

In cases where crosstalk volume measurements indicate circuits to be in trouble, crosstalk coupling measurements may also be used as a supplementary procedure for isolating the trouble to a particular part of the circuit.

Based on this requirement, curves have been prepared showing the minimum working net losses for various lengths of the several types of cable facilities.

Application of Crosstalk Coupling and Crosstalk Volume in determining Minimum Crosstalk Net Losses.

The nature of crosstalk coupling makes it more readily applicable as a basis for the design and layout of circuits, since its magnitude can be controlled by exercising care in these functions and in the construction of the circuits. Crosstalk coupling also serves as a useful supplemental test in determining the sources of excessive crosstalk on working circuits. Crosstalk volume, on the other hand, is a more suitable objective measurement of the overall performance of a circuit from the crosstalk standpoint, since it includes the crosstalk coupling and the effects of the other attendant conditions mentioned above, some of which are dependent on the subscriber's use of the telephone and are not readily controllable.

The present data indicate that in order to keep the chance of hearing intelligible crosstalk to a satisfactorily low value in the Bell System, the crosstalk coupling on quiet circuits between the point of zero (relative) level on the disturbing circuit and the receiving terminal at the toll switchboard on the disturbed circuit should not have a numerical value less than 60 db, in more than about 1 per cent. of the cases.

Recommendations.

In view of the foregoing considerations, it is recommended :—

1. That crosstalk volume be defined in terms of the reading of the crosstalk volume indicator, expressed in db above reference noise. (Reference noise is that circuit noise which gives the same

reading as that obtained from 1 micro-microwatt at a frequency of 1 000 cycles when measured on a circuit of 600 ohms pure resistance.)

2. That the essential characteristics of the crosstalk volume indicator be specified by the 3rd C.R.

3. That an objective method be adopted for determining the overall service performance of circuits from a crosstalk standpoint, making use of the crosstalk volume indicator.

4. (*a*) That statistical data be obtained by the several Administrations regarding the reactions of a large number of observers to various values of crosstalk volume under controlled and varying conditions of room and circuit noise and using specified types of subscriber instruments at both the sending and receiving ends of toll connections. From such data the percentage of observers who consider crosstalk volume of a particular value intelligible under these specified conditions may be determined.

(*b*) That these data be supplemented by crosstalk coupling measurements of the particular toll plant on which the above crosstalk volume data are obtained.

These data are considered essential in order that a relation may be determined between various assumed values of crosstalk coupling and the percentage chance of hearing intelligible crosstalk under the specified conditions.

5. That each of the member Administrations be invited to obtain statistical data on the crosstalk performance of circuits, of the types of construction recommended by the C.C.I.F., in their respective territories. These data should be obtained during the relatively heavy traffic periods (i.e. during the busy hour) and should include measurements of both crosstalk volume and crosstalk coupling, the latter measurements to be made on individual repeater sections, and, where practicable, on the complete toll circuits. Sufficient crosstalk volume measurements should be made to determine the limiting distribution of crosstalk volume.

6. That the experimentally determined relationship between crosstalk coupling and the chance of intelligible crosstalk obtained in " 3 " be applied to the results of measurements of actual plant conditions in " 4 " for the purpose of determining acceptable criteria of crosstalk performance, and from these, the limiting crosstalk coupling values for use as a basis in design and circuit layout work.

Question No. 13. Near-End Supervision and Voice Frequency Signalling (Category A2). 3rd C.R. in collaboration with the 6th C.R. (Continuation of Transmission Questions Nos. 13 and 20 of 1935/1936.)

(*a*) Is it advisable to recommend that the installation of toll exchanges (including that of cord circuit repeaters) shall in future be so arranged that the operator at the terminal exchange at the calling end also has supervision over the called subscriber ?

If so, what arrangements should be recommended for this purpose ?

(*b*) What should be the interruptions of frequencies (between 400 and 500 p : s) which should be adopted in automatic telephony for dialling tone, ring-back tone and busy tone ?

(See the example below as an example.)

(*c*) Should a higher value (1.2 seconds, for example) be recommended for the delay of the receiving apparatus of a voice frequency ringer (at present, according to the White Book, Vol. III, p. 85, English Edition p. 202, this delay should be less than 0.8 second) ?

Note.—According to the Recommendations of the C.C.I.F. (White Book, Vol. III p. 85, English Edition p. 202) the time which elapses between the application of the voltage of a voice frequency ringer 500/20 p : s to the receiving apparatus of a ringer and the operation of the latter (that is, the " delay " of the ringer) should be less than 0.8 second. A minimum delay is necessary to permit of amplifying the signal received, rectifying it, and retransmitting it. To avoid faulty operation of the ringer by voice frequency currents, it is necessary carefully to adjust the transmitting apparatus and receiving relays both electrically and mechanically. This leads, of course, to initial and final transitory periods which are included in the total allowance of 0.8 second.

The introduction of a 2-wire long distance operation (by means of terminal repeaters on long distance circuits) has imposed a new task on the ringer receiving apparatus. When two long distance circuits are interconnected, the

receiving apparatus of the two ringers associated with these circuits is connected in parallel. It would be possible at such a switching point to cut out one of the two ringers. In present day toll operation, however, it must be possible to distinguish from which subscriber (that is, upon which circuit) comes the clearing signal or the calling signal. To permit of that, it is necessary that the receiving apparatus of the ringers at the transit exchange should be able to distinguish the direction from which the signal comes, and for this purpose an arrangement of relays is used which operates on receiving a first ringing impulse, and which takes some tenths of a second to decide from which direction the signal is received.

In spite of these additional requirements the value of 0.8 second recommended by the C.C.I.F. for the maximum delay of the ringer must be maintained. The tolerances for the initial and final transitory periods of the relay concerned must therefore be greatly reduced, which is not conducive to any satisfactory solution, in spite of the great difficulty thus created in the manufacture of relays.

It is therefore proposed to increase to 1.2 second the maximum admissible delay for the receiving apparatus of voice frequency ringers of directional sensitivity (in place of the 0.8 second limit for ringers previously established). As a Recommendation of the C.C.I.F. (White Book, Vol. III p. 84, English Edition p. 202) specifies that operators should send signals of at least 2 seconds' duration, the increased delay of the ringers (1.2 second instead of 0.8 second), will have no practical effect on the service.

It is therefore proposed to replace the first sentence of the first paragraph of page 85 of Vol. III of the White Book (English Edition p. 203) by the following :—

" **Delay.**—The time which elapses between the application of the signalling voltage, resulting from a ring of at least two seconds' duration, and the operation of the receiving apparatus of the ringer (that is to say, the retransmission of the ring) should be less than 1.2 second. The receiving apparatus . . ."

(*d*) Should not operators be given an audible control of the satisfactory receipt of their ring at the far exchange by causing the receiving relay assembly to emit a suitable signal between the moment when it has been operated and the moment when it is freed by the far operator's reply ?

Note.—It has been observed that operators frequently become impatient of a tardy reply and ring again, or, worse still, renew their ring on another circuit. The first circuit which remains in a ringing condition is then taken by a second operator who, finding no one at the other end, rings in her turn to announce her presence, great confusion in operating resulting. This trouble which has, of course, always existed, is much aggravated by direct traffic operation (no delay service) when the circuits are no longer served by one special operator. With control of ringing reception the originating operator, sure that the lamp on the board of the called exchange will light up, will await the reply without indulging in any mistaken procedure. Further, any failure of operation of the ringers, whether caused by too short a ring or by their being out of order, will be quickly revealed.

Finally, the cost of modifying the apparatus will be very moderate.

(*e*) Should not a ringing device be devised for toll exchanges which would automatically ensure a minimum ringing period on the circuits ?

Note.—It is laid down on p. 84 of Vol. III of the White Book (English Edition p. 202) that operators mus send ringing current over international telephone circuits for at least 2 seconds. This appears to be frequently disregarded by the operators, whose rings are often of very much shorter duration.

(*f*) In establishing a transit call between two circuits equipped with voice frequency ringers, should not steps be taken to avoid the ringers blocking one another during a ring ?

Note.—During a ring from circuit 1 over circuit 2 it may happen that by reason of its greater sensitivity the ringer of circuit 2 will operate before that of circuit 1 and thus cause jamming.

(*g*) In view of the introduction of V.F. dialling and code signalling on national networks, what conditions should be observed by the national systems in order to prevent V.F. signals which are being used on a line in one national network, from affecting the operation of V.F. signalling apparatus on a line in another national network to which the first line may be connected by any means whatsoever?

Annex to Question No. 13.

Signals obtained by the calling operator on circuits using two frequency signalling in Great Britain.

Number Unobtainable tone.

400 p : s.

The " number unobtainable " signal is obtained if it is not possible to reach the subscriber called for any reason ; e.g. if the line concerned is a reserved line, or if the line is temporarily out of service.

On a circuit using two frequency signalling the number unobtainable tone is interrupted (signal 4 seconds, interruption 1 second) to avoid blocking the circuit when echo-suppressors are used on the toll circuit.

Busy Tone.

400 p : s (signal 0.75 second, interruption 0.75 second).

The busy tone is obtained if the subscriber's number called is engaged or about to be engaged.

The normal periods of interruption of the " busy tone " are long enough to avoid the blocking of the circuit if echo-suppressors are installed on it.

Ring-back-Tone.

133 p : s.

The 3rd harmonic of this signal is transmitted over the circuit (signal 0.4 second, interruption 0.2 second, signal 0.4 second, interruption 0.2 second, and so on).

The ring-back tone is given to indicate that the subscriber asked for is being called. On the latter's answering, the signal ceases.

On a circuit with two frequency signalling the normal cycle of the number unobtainable tone is interrupted (signal 4 seconds, interruption 1 second) at the sending side of the ringer. Such interruption, which is not in any way synchronised with the ringing tone cycle, in practice leads to no confusion. Hence, no attempt has been made to further differentiate between the number unobtainable tone and the ring-back tone in the receiving side of the ringer.

Dialling Tone.

No dialling tone is given to the calling operator when calling a number in a non-director automatic exchange, because an incoming selector is permanently associated with the junction line, and is immediately in the circuit when the operator uses the junction.

When the operator takes a connection to a director system exchange a single signal at 900 p : s is given to indicate that dialling can commence.

Signal and Dialling Frequencies.

Voice frequency currents at 600 and 750 p : s are used for this purpose.

Calling:

The signals are as follows :—750 p : s transmitted for 200 to 300 milliseconds by receiving side of the ringer.

Reply of the Called Subscriber :

600 p : s for 200 or 300 milliseconds by the receiving side of the ringer.

Called Subscriber's Hang-up Signal :

Successive impulses of 600 p : s interrupted (signal 0.14 second, interruption 0.36 second) transmitted by the receiving side of the ringer.

Clearing Circuit after Call :

750 p : s for 2 seconds followed by 600 p : s for 250 milliseconds sent by the transmitting side of the ringer.

Clearing Circuit although the Caller Subscriber has not replied : 750 p : s for 6 seconds followed by 600 p : s for 250 milliseconds, sent by the transmitting side of the ringer.

Dialling Tone :

Impulses at 750 p : s (signal of 66 milliseconds interrupted for 33 milliseconds) sent by the transmitting side of the ringer.

Question No. 14. Non-Linear Distortion on Broadcast Circuits (Category A2). 3rd C.R. in collaboration with the 5th C.R. and the U.I.R.

Should the C.C.I.F. recommendation be modified which concerns the non-linear distortion admissible for broadcasting circuits, and which is given on p. 167 (English Edition p. 247) of Volume III of the White Book?

Note.—In some cases where somewhat high values of the co-efficient of harmonic distortion have been obtained, the music transmission over the circuit has nevertheless been recognised as being relatively good by the Radiodiffusion Authorities. The value of the co-efficient of harmonic distortion admitted by broadcasting stations, however, is 4 per cent. for a 90 per cent. modulation, and it is anticipated that a further reduction will be made.

It is desirable that the various Administrations and Operating Companies test their networks in this respect in collaboration with the Radiodiffusion Authorities and forward their results to the Commission Mixte C.C.I.F./U.I.R. before the 31st December, 1936.

Annex to Question No. 14.

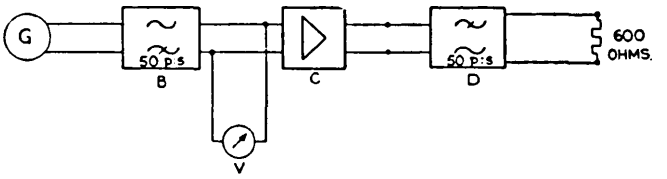
In the case of special circuits for broadcasting the variation of overall attenuation as a function of the amplitude does not appear to be of importance since there is no need to study stability (circuits for one-way transmission). It is necessary, therefore, to devote attention to the production of harmonics, and especially of differential tones, and, to a lesser degree, the flutter effect.

In view of the fact that differential tones may be produced either by a combination of the fundamental components of the voice or by a combination of the harmonics of these components, the whole band of frequencies effectively transmitted must be studied.

It is proposed that the following procedure, that of Dr. Ribbeck, shall be followed :—

The " coefficient of differential tones " is defined as being the relation between the effective value of the differential wave with that of the mixture of fundamental frequencies in which the differential wave has been suppressed.

The apparatus described by Dr. Ribbeck includes a generator *G* of two frequencies (separated by 50 p : s) followed by *B*, a high pass filter with a cut-off of 50 p : s, *C*, a terminal amplifier, and *D*, a low pass filter with cut-off of 50 p : s. A voltmeter *V* measures the voltage at the input of the amplifier.



The voltage at the input of filter *D* is compared with the voltage at its output. The coefficient of differential tones is the relationship of these two values.

Using a recording transmission measuring set a curve showing the variation of this coefficient as a function of the frequency, at constant input voltage can readily be traced.

Administrations and Operating Companies having broadcast circuits are asked to bring the two ends of such a circuit into a room having good acoustical qualities (a quiet room where echo is slight). Experts would then listen to good quality music, first at the input and then at the output of the circuit, and would compare the quality of the music, the latter being maintained at uniform strength. The level of the circuit would be raised, keeping the strength constant, to cause the non-linear effect to appear.

A request is made that, during these tests, the coefficient of differential tones defined above should be measured. Administrations are asked to send in both curves showing the variation of the co-efficient of differential tones and the results of the appreciation tests of musical quality at the end of the circuit.

A recommendation is also made that the distortion due to flutter should be measured. This is defined as being the variation of the overall attenuation of the circuit at one frequency due to the simultaneous transmission of another frequency over the circuit.

As an example it may be mentioned that in Germany it was found that the quality of the music received was equal to that of the music transmitted on a circuit whose coefficient of differential tones reached 7 per cent. maximum in a frequency range of 50-6 400 p : s whose distortion, due to flutter, reached 0.8 neper and whose coefficient of harmonic distortion reached 10 and even 17 per cent. for some of the frequencies transmitted.

Question No. 15. Impedance of International Circuits (Category A2). 3rd C.R.

In view of the fact that numerous impedance measurements recently made in Europe on national circuits seen from the terminals of the international circuits have shown large differences in value, and as the internal impedance of the transmission measuring arrangement is equal to 600 ohms pure resistance, would it not be advisable to revise the C.C.I.F. recommendation concerning the apparent impedance of international circuits (White Book, Volume III p. 130, English Edition p. 227) ?

Question No. 16. Message Recording Systems (Category B). 4th C.R. (Continuation of Transmission Question No. 16 of 1935/1936.)

Technical conditions to be fulfilled by message recording systems :—

(*a*) Where these are used by certain telephone users ?

(*b*) Where these are used at traffic control desks ?

Question No. 17. Subset Efficiency (Category B). 4th C.R.

What are the efficiency curves as a function of frequency of the transmitting and receiving systems of the main types of telephone sub-sets at present in use in Europe ?

Note.—With regard to this subject the following literature is available :—

1*a*. Siemens-Halske : " Der Neue Fernsprecher Modell 36."

1*b*. H. Jacoby und Panzerbieter : " Ueber Moderne Mikrophone und Telephone," ENT. 3, 15, 1936.

2. A. H. Inglis, C. Gray, R. Jenkins : " A Voice and Ear for Telephone Measurements," *Bell System Technical Journal* 293, 1932.

3. B. McMillan : " Some Performance Characteristics of the Subscribers' Telephone Transmitter," *Post Office El. Eng. Jrnl.*, 3-167, 1935.

It would be beneficial if this list could be completed by the indication of other articles already published on this subject.

If these articles do not give a complete description of the form of such characteristic curves of efficiency as a function of frequency between the threshold of operation and the saturation limit of these instruments, it would be desirable that the various Administrations and Operating Companies who already have this information should send it to the secretariat of the C.C.I.F.

It would also be desirable (if the articles already published do not give these indications) to complete the information by making known in detail the methods used to obtain these efficiency curves as a function of frequency both for the transmitting and the receiving systems.

This information will be of use in the future studies of limits admissible for the effective transmission equivalent for national transmitters and receivers.

Question No. 18. Measurement of Room Noise (Category A_1). 4th C.R. (Continuation of Transmission Question No. 18 of 1935/1936.)

What essential characteristics for measuring instruments for room noise should be adopted ?

What reference zero should be adopted in these measurements ?

How could this apparatus be used for measuring room noise which varies rapidly in intensity ?

Note.—In the study of part (*a*) the C.C.I.F. will continue to collaborate with the International Electrotechnical

Commission. Administrations and Operating Companies are requested to complete the published information held by the C.C.I.F. of detailed descriptions of measuring apparatus (subjective or objective) for room noise which are already in current use.

Question No. 19. Measurement of Reference Equivalent of Side Tone (Category A2). 3rd C.R. in collaboration with the 4th C.R.

(*a*) Which are the mean characteristic curves showing the variation as a function of frequency of the two impedance components of the line seen from the terminals of the subscriber's set in the case of an international call ?

Note.—When the reference equivalent of side tone of a subscriber's set is measured in a laboratory, service conditions are simulated by closing the terminals of the sub-set by an impedance of which the components vary, as a function of frequency, in agreement with the mean characteristic curves mentioned above, for the country considered.

(*b*) Would it be possible, making use of the mean characteristic curves for the various countries, to specify (at the various frequencies) what impedances should be connected across the " line " terminals of the sub-set when measurements of the reference equivalent of side tone of sub-sets from different countries are being made in the SFERT laboratory.

Question No. 20. Automatic Ringing on International Circuits (Category A2). 3rd C.R. in collaboration with the 6th C.R.

In view of the fact that the frequencies selected for automatic ringing on international circuits (toll dialling) are 600 and 700 p : s,

(*a*) Is it possible to establish an agreed method of using these two frequencies ?

(*b*) If so, what method should be recommended ?

Question No. 21. Non-Linear Distortion in Subscriber's Equipment (Category A_1). 4th C.R. (Continuation of Transmission Question No. 22 of 1935/1936.)

(*a*) What is the criterion best describing the non-linear distortion of subscribers' apparatus ?

(*b*) What are the best methods to use in the measurement of the non-linear distortion of subscriber's apparatus ?

(*c*) What is the transmission impairment due to the non-linear distortion of the subscribers' microphone.

Annex to Question No. 21.

Important contributions to the study of this question have been made by the German Administration and the British Post Office in particular.

The German Administration has carried out fundamental research on the subject of reduction in transmission quality due to the non-linear distortion of microphones. As the carbon microphone possesses in addition to its non-linear distortion very pronounced attenuation distortion, it was first of all necessary to determine the effect of the latter. For this purpose a filter network was constructed which reproduced the attenuation distortion of the carbon microphone. This filter network was inserted after the condenser microphone of the reference system for telephone transmission which has neither non-linear nor attenuation distortion. In this manner, therefore, it was possible to determine the reduction of articulation due to attenuation distortion. To study the effect of non-linear distortion on articulation, an arrangement is inserted after the condenser microphone and the filter network simulating the attenuation distortion of a carbon microphone, which introduces a measurable non-linear distortion, in the shape of a valve in which the polarisation voltage of the grid can be varied (the coefficient of harmonic distortion being measured by the Kupfmüller bridge).

The articulation loss due to attenuation distortion in one particular instance was 4 per cent., whilst the articulation loss due to non-linear distortion was approximately 10 per cent. (see document " C.C.I.F. 1935/1936—Transmission Document No. 17 ").

The German Administration in the course of recent research, the results of which have not yet been published, has determined the dynamic characteristics of carbon microphones (the relation between the acoustic pressure on the diaphragm and the E.M.F. supplied by the microphone), by means of a cathode ray oscillograph (Braun's tube). These characteristics, ascertained during this research, took the form of loops curving inwards more as the applied acoustic pressure was increased.

The tests carried out by the British Post Office have been made so as to take into consideration the various factors given below :—

1. Effect of amplitude. The working characteristics of the microphone at the different frequencies vary with the acoustic pressure applied to the diaphragm ; they also depend upon the current supplied.

2. Floating effect. If two sinusoidal waves are applied simultaneously to the diaphragm of the microphone, the efficiency of the microphone with regard to one of these waves depends also upon the characteristics of the other.

3. Production of harmonics. The second harmonic appears to be practically independent of the acoustic pressure on the diaphragm of the microphone and of the frequency. It is not known, however, whether or not this second harmonic depends upon the current of supply. It is thought that this harmonic could be used as a criterion of non-linear distortion. It should also be mentioned that no well-defined relation between this second harmonic and the size of differential sounds has been established.

4. Production of sub-harmonics. It has been noted that sub-harmonics are produced when the acoustic pressure applied to the diaphragm of the microphone exceeds a certain value.

5. Articulation tests similar to those made by the German Administration have also been carried out. An electrodynamic microphone was selected which at a certain acoustic pressure had the same operating characteristics at the various frequencies as the carbon microphone used. A very considerable articulation gain has been noted with the electromagnetic microphone which was free from non-linear distortion.

Although the variation in resistance of the carbon microphone may have some relation to the effect of non-linearity (especially the amplitude effect) it does not seem possible that this resistance variation can be adopted as the criterion of non-linearity.

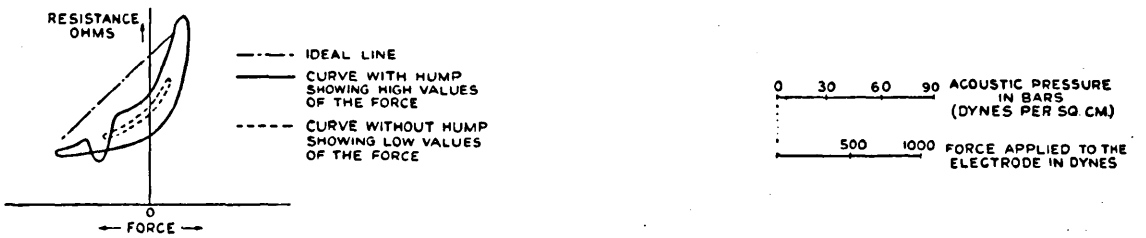
A further contribution has also been made by Dr. Sutton. In particular, he has presented formulae relating the operating characteristic at various frequencies to the electro-acoustic-mechanical parameters of the microphone.

Thus, given the characteristics of a microphone it is possible to plot its working curve at various frequencies, or, given this curve, to ascertain the parameters. The calculated results have been found to agree very well with the results ascertained by measurement.

In a later study, which has not yet been published, Dr. Sutton has investigated the causes of non-linearity in a carbon microphone. He has first of all investigated whether transitory phenomena in the vibrating portions of the microphone might be the cause, but has ascertained that the effects of these were negligible. He has then investigated whether the mechanical construction of the microphone housing or other metallic portions had any effect, again with negative result. Tests were then carried out on the capsule itself. When the acoustic pressure is increased, though remaining within the limits met with in a normal conversation a certain pressure value is found above which a bouncing effect is produced which is revealed by a rapidly recognisable sound. This proves the existence, within the normal limits of acoustic pressure met with in telephony, of a critical value of acoustic pressure. Using a cathode ray oscillograph a curve has been traced showing the variation in resistance of the capsule as a function of the sinusoidal mechanical force applied to the diaphragm of the microphone.

With the assembly used, the relation given by the following curve was found to exist between this force and the corresponding acoustic pressure.

It will be noted that this curve shows a very distinct deviation for all values of acoustic pressure above the critical pressure; the curvature and the slope of this characteristic explain the various effects of non-linearity observed in a microphone.

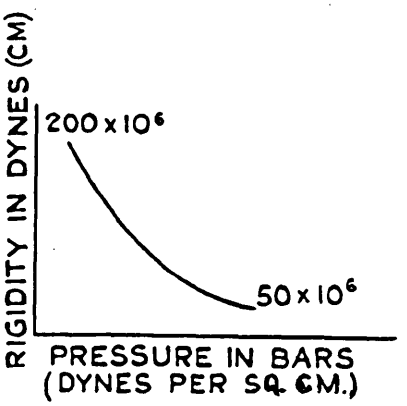


During the tests on the cathode ray oscillograph screen, the lower part of the curve was extremely stable. The upper portion corresponding to the low pressures where the non-linearity is serious, was in constant agitation indicating great instability in the capsule.*

By displacing in a magnetic field a coil wound on a diaphragm (moving coil) a potential is obtained proportional to the speed of this diaphragm. By applying this potential to an integrating electrical device, another potential can be obtained which is proportional to the displacement of the diaphragm. By applying this last potential to one of the plate pairs of a cathode ray oscillograph, and by applying to the other pair a potential proportionate to the mechanical force exerted on the diaphragm, a fresh curve is obtained. It has been noticed that this last curve exactly coincides with the first curve obtained.

There is therefore no phase displacement between the movement of the diaphragm and the variations in the resistance of the capsule, at the frequencies used in these tests.

From Dr. Goncher's work on a single contact between a carbon granule and a smooth electrode, it is possible to determine for a given capsule a curve of the mechanical pressure, of the granules in dynes per cm^2 as a function of the effective value of the acoustic pressure applied to the diaphragm expressed in bars.



The curve shown is obtained, the incurving form of which partly explains non-linearity effect. To sum up, this non-linearity effect appears, therefore, to be due to two principal causes, (1) the effect

* It is true that in the higher part of the curve the alternating force is large, but it operates in opposition to the static pressure on the granules; consequently the resultant force is small. On the other hand, the alternating force in the lower part of the curve operates with the static pressure on the granules and consequently the resultant force is large. On the above diagram the alternating force only has been used as abscissae and not the static pressure on the granules, which is always in operation.

of the mechanical bouncing of the diaphragm when the acoustic pressure, although remaining within the limits met with in telephony, reaches or exceeds a certain critical value, and (2) the variation of the mechanical pressure of the granules as a function of the acoustic pressure applied.

Dr. Hartman also has recalled that attempts to determine by calculation the production of harmonics in carbon microphones, have never been successful when it was assumed that it was a matter of single value functions. He also draws attention to the existence in carbon microphones of an " operation threshold."

Besides the mechanically stable operation zone and the unstable operation zone of the capsule, there also exists in the range of variable pressure met with in practice, a first non-operating zone of the microphone.

In Germany particular attention has been paid to the study of the production of differential sounds by the method, due to Messrs. Van Braunmühl and Weber, of applying two sinusoidal waves of different frequency to the microphone. It has been observed that no definite relation exists, on the one hand between the amplitude of the differential sounds and the amplitude of the harmonics, and on the other hand between the magnitude of these differential sounds and such reduction of transmission quality as can be observed by the ear.

Lastly, the SFERT laboratory is making during 1936 a series of experiments on the subject of non-linear distortion. It would be useful if the German, British, French and Swedish microtelephone sets which are used in these experiments could be submitted by their respective Administrations to certain physical tests with a view to determining the magnitude of the following values, which may possibly serve as a criterion of non-linearity :—

1. Determine the percentage relationship of the square root of the sum of the squares of the amplitude of the harmonics and sub-harmonics at the output of the microphone, and the effective value of the fundamental also measured at the output of the microphone. This value gives the effect of harmonic distortion. The test should be made with a sinusoidal wave of 750 p : s applied to the microphone. A sub-committee consisting of Messrs. Braun, Chavasse, Markman and Dr. Sutton will be set up to determine the exact method for making this test.

2. Having studied the operating characteristics at the various frequencies, measurements will be made of the absolute sinusoidal efficiency of the microphone at a frequency corresponding to the highest point in the frequency band effectively transmitted. The results will be presented as a curve, the abscissae for which will be the relative values of acoustic pressure expressed in decibels with regard to 1 bar, and the ordinates the absolute efficiencies expressed in decibels with regard to 1 volt per bar.

3. It would also be interesting, if the above-mentioned Administrations find it possible, to obtain information on the dynamic characteristics of the microphone : the relation between the instantaneous resistance of the microphone and the instantaneous value of the E.M.F. which it produces. These tests would be made under sinusoidal conditions at the chief resonant frequency, in the frequency band transmitted.

All these tests will be made on commercial microtelephone instruments as similar as possible to those sent to the SFERT laboratory.

This programme of tests will permit of answers being obtained to parts (*a*) and (*b*) of Question No. 22. The tests carried out by the various Administrations and by the SFERT laboratory will provide the answer to part (*c*).

Note.—The American Telephone and Telegraph Company has mentioned that in repetition tests the effect of non-linear distortion of the microphone is taken into account. Hitherto in the U.S.A. no need has arisen for a separate value for the effect of this factor on transmission quality. Investigations on this subject are now being made.

Note 2.—Certain information is available as to the non-linear distortion of receivers. The production of harmonics, and especially of the 2nd harmonic, depends strictly upon the resonant frequency of the receiver, but in practice the effect is negligible.

Question No. 22. Standard Room Noise (Category A_1). 4th C.R. (Continuation of Transmission Question No. 24 of 1935/1936.)

Should not the various reference room noises used in telephono-metric measurements be unified ? If it is not possible to specify physically this room noise could not a special record, capable of being reproduced many times, be made for general use ?

Question No. 23. Effective Rating (Category A_1). 4th C.R. (Continuation of Transmission Question No. 26 of 1935/1936.)

(*a*) Continuation of the study of the idea of effective transmission equivalent.

Note.—As data on the transmission quality of apparatus in use in the various countries are required for the application of a General Toll Switching Plan for Europe, the SFERT laboratory will make a series of tests on an articulation basis in accordance with a detailed programme drawn up by the 4th C.R. These tests will specify, from an articulation standpoint only, between what limits and under what conditions of transmission, the idea of effective transmission equivalent is applicable. These tests also will constitute a first step in the establishment of a method of comparison for subscribers' apparatus with the SFERT on an articulation basis.

The results of these tests at the SFERT laboratory will be published in bi-monthly reports and examined by the 4th C.R., who will then be able to specify the methods to be adopted for later tests.

(*b*) Specification for a reference system for the direct measurement of the effective transmission equivalent of any one telephone system or part thereof.

(*c*) Method of measurement to be used in determining effective transmission equivalents.

Question No. 24. Reference Volume (Category A_1). 4th C.R. in collaboration with 5th C.R. and the U.I.R. (Continuation of Transmission Question No. 30 of 1935/1936.)

What value should be adopted as a reference volume, and how should the zero point of the scale be determined when calibrating volume meters ?

Seeing that the scale of the psophometer is graduated in millivolts, would not a value of 1 volt at 1 000 p : s be suitable for calibration purposes ?

Would it not be well to consider also the zero point to be universally used in the calibration of noise meters (subjective acoustic reference intensity) ?

Note 1.—In the study of this question, it should be considered whether the terminology proposed by the British Post Office in the annex which follows would not be more suitable than that in actual use.

Note 2.—Three suggestions have been put forward concerning the reference volume for vocal sounds.

1. The American Telephone and Telegraph Company proposes that the " reference volume " definition should be maintained which is based on the use of a calibrating power of 6 mW at 1 000 p : s, stating that when dealing with vocal sound where the wave form varies considerably with time, it would be an advantage to have a reference value differing from that used in circuit measurements, where the wave form is constantly sinusoidal.

2. The German Administration proposes that the definition of reference volume should be based on a calibrating power of 1 mW at 800 or 1 000 p : s stating that in the first place it is necessary to speak very loudly into the reference system to obtain the reference volume, and secondly that the value of 1 mW would correspond with the zero reference used in circuit measurements.

3. The British Post Office proposes that since in practice measurements of volume are made with a special voltmeter, and that when circuit noise measurements are made the results of measurements with the psophometer are expressed in millivolts, volume meters should be graduated in decibels in relation to a sinusoidal voltage of 1 volt at 1 000 p : s.

Note 3.—Some Broadcasting Organisations also are of opinion that a reference volume for music corresponding to some power of constant sinusoidal wave form (1 to 6 milliwatts according to the country) should be considered. This fact should be taken into consideration in the study of this question, which is why the collaboration of the U.I.R. is required.

Annex to Question No. 24.

Terminology concerning volume meters proposed by the British Post Office.

The conclusions reached by the British Post Office in recent studies are briefly as follows :—

1. An exact measurement of the volume of vocal sound can only be made when its magnitude has been precisely defined.

2. This definition is necessarily arbitrary ; the most convenient method is to express it as a function of the reading on the scale of a volume meter, the operation of which is specified.

3. The reason why such terms as " speech volume " or " speech power " and " volume indicator " have never been precisely defined is probably that for a long time they have been used in a general manner with different shades of meaning.

4. To avoid confusion it would seem advisable to abandon these expressions and to adopt new expressions having a well defined meaning. It is suggested therefore that the following terms should be used :—

" Speech voltmeter " in place of " volume meter " (volume indicator or impulse indicator).
" Speech voltage " in place of " volume "

and

" Speech pressure " to designate the pressure at any one point of an acoustic wave originated by the human voice.

5. The " speech voltage " corresponding to a logatom would be defined and measured by a reading made on the scale of a " speech voltmeter " of detailed specification.

6. The " speech pressure " corresponding to a logatom requires, for its definition and measurement, that a calibrated microphone, practically distortionless, should be associated with a " speech voltmeter."

Question No. 25. Articulation Rating (Category A_1). 4th C.R. (Continuation of Transmission Question No. 33 of 1935/1936.)

(*a*) What numerical data should be finally adopted to allow of the calculation of the articulation of a telephone system from the electrical constants of that system ?

(*b*) What is the best method to use for calibrating the articulation test crews of various countries at different periods ?

(*c*) Instead of carrying out articulation tests with " constant volume " would it not be better to give each operator a volume value so that the various results of individual tests would simulate those conditions met with in practice ?

If so, what values of volume should be used, it being understood that in order to fix these values it will be necessary to study the mean quantitative effects of room noise and side tone on the vocal power of the subscriber under the actual conditions of commercial telephone service ?

The determination is indicated at the same time of the combined effect, from a transmission standpoint, of room noise and side tone on reception.

(*d*) Would it be possible to adopt a phrase, formed from a sequence of logatoms, in which to announce the logatoms with a constant volume during international articulation measurements (see White Book, Volume IV, pp. 212 to 215, English Edition p. 459, Section C, Measurement of Articulation, paragraph *b*, Operating Method), and if so, could this sequence of logatoms be used to establish a relation between the volume meters of different types in use in various countries ?

Note 1.—With reference to point (*a*) an article by Dr. Collard entitled " Calculation of the articulation of a telephone circuit from the constants of that circuit " will be found in the Yellow Book (Brussels 1930), pages 153 to 194.

In order to arrive finally at a calculation instead of a measurement of articulation in almost every case where an absolute value of articulation is desired, the necessary data should be obtained by several Administrations by means of crews of about twenty members. From the data so obtained, curves could be deduced of universal use in calculating articulation.

For such tests the filters shown below should be used :—

1.	Low-pass filters	1 200 p : s
	,, ,,	800 p : s
	High-pass filters	1 000 p : s
	,, ,,	1 500 p : s
	,, ,,	2 000 p : s

These filters are already in the SFERT laboratory.

2.	Low-pass filters	500 p : s
	,, ,,	1 500 p : s
	,, ,,	1 900 p : s
	,, ,,	2 400 p : s
	,, ,,	3 000 p : s
	,, ,,	3 600 p : s
	High-pass filters	500 p : s
	,, ,,	800 p : s
	,, ,,	1 250 p : s
	,, ,,	2 500 p : s

These filters, which must be made, should have a constant impedance of 600 ohms at all frequencies and a minimum attenuation of 9 nepers in the suppressed band.

For the new series of tests foreshadowed above which must be made with the use of the foregoing filters an overall attenuation value for the telephone system of 30 decibels, not including the attenuation of the filters, must be used.

Note 2.—With reference to point (*b*) the American Telephone and Telegraph Company have commented as shown in Annex 1, on the subject of the comparison of the respective advantages of the various methods of calibrating a testing crew for articulation testing (methods described in White Book, Volume IV, pages 219 to 230, English Edition page 467, etc.).

Note 3.—With reference to point (*c*) the Rumanian Telephone Company has put forward the suggestions contained in Annex 2, " Effective Articulation."

Annex 1 to Question No. 25.

Observations of the American Telephone and Telegraph Company regarding Articulation Testing Crew Calibration.

C.C.I.F. 1935/1936 Transmission Document No. 8 contains a derivation by Dr. J. Collard of a curve showing the relation between " ideal band articulation " and " ideal sound articulation " for testing material consisting of Esperanto logatoms. This curve forms part of the method for calibrating articulation testing crews described in the White Book, Volume IV, pages 219-228.

The Document contains also a derivation by Dr. Collard of the constants which are required for computing the articulation of a circuit for logatoms from the circuit constants by the method described by him (Yellow Book of 1930, pages 153-194). This consists of the determination of b and p, the former showing the distribution of " ideal band articulation " with frequency, the latter representing a weight factor depending upon the attenuation of the individual bands. Curves given in Fig. 1 show a comparison between the observed articulation data and computed results using the constants derived from these same data. Fig. 2 shows an independent comparison of computed and observed values of articulation for the SFERT with distortion.

In view of the small amount of independent comparisons between observed and computed results using the constants derived from the tests on the SFERT without distortion, and the importance of establishing the limitations of any computational method before applying it extensively, brief mention is made here of the experience of the Bell System in connection with these matters.

Work along the lines of investigating the effect of such characteristics of circuits as distortion and volume on the reproduction of speech, the establishment of methods of computing articulation from the physical performance of circuits and the correlation of the results of different articulation testing

crews, and their calibration has long been a matter on which considerable emphasis has been placed by the American Telephone and Telegraph Company. This was one of the principal objectives for developing the circuit now represented by the SFERT and the duplicate reference system maintained by the Bell System. Articulation tests carried out between 1916 and 1922 on high pass, low pass, and band filters and resonant networks inserted in this system, provided basic data which were brought together into a set of formulae which has been of considerable value in studies of transmission performance. While much of the data obtained during these tests has been published (see " Speech and Hearing," by Harvey Fletcher) the particular formulae developed have been considered as tentative and subordinate in importance to actual experimental results. Since the conclusion of these earlier tests, a great many additional tests have been made which have resulted in revisions of the earlier formulae. This work is being continued, for experience indicates that not all laboratory results can be predicted with the accuracy desired. A number of formulae have been tested, some of them quite similar to those of Dr. Collard. While these could be made to fit the data satisfactorily for filters at optimum levels of received speech with linear systems, difficulties are met when the formulae are extended to circuits such as resonant circuits in which most of the frequency range of speech is present but is suppressed in various degrees, and to circuits containing non-linear distortion. For the Bell System testing material at least, it appears that the weighting factor denoted by p in Document No. 8 is not independent of frequency.

Other specific points might be made, but the situation with respect to all such formulae may be summed up by noting that they are essentially empirical. Various hypotheses as to the nature of speech may be used as a guide to the development of the formulae, but the fact remains that these hypotheses in the long run appear in the formulae as weighting factors to be determined experimentally. This appears to be as true of Dr. Collard's formulae as of those of the Bell System, and in view of the complicated situation embodied in the formulae, it may remain true for some time. The practical consequence of this fact is that any set of formulae must be tested over a wide range of conditions. In addition to the circuits described in Transmission Document No. 8 tests of interest would include, for example, resonant circuits of various degrees of damping and of different natural frequencies, and also laboratory models of commercial telephone circuits. In each case a wide variation of the level of the received speech would provide a more exacting test of the formulae than is the case if a single level only is used.

This leads up to the matter of calibrating testing crews which the American Telephone and Telegraph Company believes also to be essentially empirical. It has approached the problem in several ways, one of them, which is no longer advocated, being that described in the English Edition 1934, page 469.

It is of interest, in this connection, to point out that the calibration method advocated by Dr. Collard may also be presented as a family of curves. These have been worked out, using the curve for Esperanto logatoms shown in Document No. 8, Fig. 79, and are shown on page 305. As ordinates are plotted the values of sound articulation which would be obtained by an " ideal " crew on a circuit for which the actual crew obtains the values shown as abscissae. Each curve represents a particular value of Z, the practice co-efficient used by Dr. Collard.

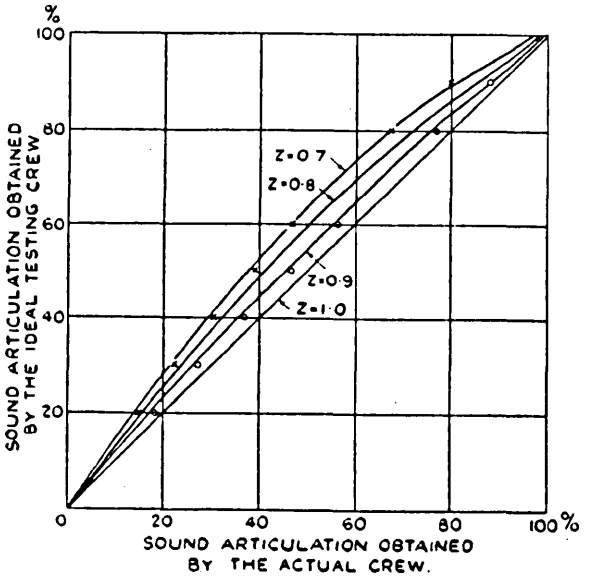
When this family of curves is compared with the curves referred to in the previous paragraph (English Edition 1934, page 470) a remarkable similarity may be observed between the two families. This comparison is shown also in the drawing by points denoted by crosses and circles which indicate two members of the family of curves in the White Book. The coincidence is striking, but a still further coincidence may be pointed out: namely, that the particular exponents, x, of the expression

$$(1-L) = (1-L_0)^x \quad (L = \text{sound articulation})$$

which fit the curves of Dr. Collard's family, have the same numerical value as the practice co-efficient

Z. In other words, it would appear that over the range of articulation of interest no experimental results are likely to distinguish between the two methods.

This coincidence does not, however, constitute a proof of either method. The American Telephone and Telegraph Company still feels that experimental correlations should be obtained before theoretical correlations are accepted. The question still unanswered is this : If Crew A obtains a value X and Crew B a value Y on a given circuit, will Crew B obtain a value Y on all circuits on which Crew A obtains a value of X ?



COMPARISON OF METHODS OF CALIBRATING ARTICULATION TESTING CREWS

Note.—The curves represent the method described by Dr. John Collard, for which data are given in " C.C.I.F. 1935/1936 Trans. Doc. No. 8."

The points represent the method shown in the C.C.I.F. White Book, Vol. IV, p. 230, for $x = 0.70$ (crosses) and $x = 0.90$ (circles). (English Edition p. 470.)

Annex 2 to Question No. 25.

Suggestions by the Rumanian Telephone Company concerning Effective Articulation.

In the usual type of articulation test the calling volume of the talker is maintained at a constant value by means of a volume indicator or other device. The calling volume is therefore independent of the type of circuit being tested and the value of articulation obtained in this way can be called the " constant volume " articulation.

In the case of an ordinary telephone conversation the calling volume is not constant. In the first place there are variations from one subscriber to another due to the natural differences in their voices.

In the second place, even if we consider the average calling volume of a large number of subscribers, there are variations which depend on the circuit conditions. These variations can be divided into the following groups :—

(*a*) Variations due to the conditions at the calling end. As an example may be quoted the effect of room noise at the talker's end. An increase in this noise causes the talker instinctively to raise his voice, while in quiet surroundings he tends to talk in a quieter voice.

(*b*) Variations due to conditions at the listening end. An example of this is room noise at that end. The effect of this is to prevent the listener from hearing properly, and so to provoke him to ask the talker to speak more loudly.

(*c*) Variations due to circuit conditions. An example of this is the line attenuation. If this is high the listener receives a low volume and therefore requests the speaker to talk more loudly, while if it is low the listener receives an uncomfortably loud volume and asks the speaker to talk more quietly.

(*d*) Variations due to the fact that each subscriber instinctively tends to adjust his calling volume in accordance with the level of speech he receives from the other subscriber. For example, if the line has high attenuation the listening subscriber receives low level speech and thus gets the impression that the other subscriber is a long way away. He therefore instinctively raises his own voice when it is his turn to speak. This effect is in the same direction as that mentioned in (*c*).

In the case of room noise at one end, this causes the subscriber at that end to raise his voice. The subscriber at the other end thus receives loud speech and, if there is little room noise at his end, he instinctively lowers his voice when it is his turn to speak. Thus the subscriber in the quiet location receives loud speech while the subscriber in the noisy location receives quiet speech. This is just the reverse of what is required so that this effect to some extent cancels the previous effect described under (*b*).

Since these instinctive adjustments of calling volume take place during a telephone conversation but do not occur during a constant volume articulation test, it follows that the effect of such factors as noise, attenuation, etc., as judged by a subscriber, is not necessarily the same as would appear from the constant volume articulation test. It is generally agreed that circuit ratings should be determined so that they correspond to service conditions and it therefore follows that if we wish to make use of articulation tests, we must abandon the old " constant volume " type of test and arrange to simulate in some way the calling volume adjustments occurring in telephone conversations. It is suggested that the modified form of articulation test in which the variable volume effect has been taken into account, and which does, therefore, give a true measure of the performance under service conditions, should be called the " effective " articulation. We should then have two forms of articulation test, the " constant volume " test which might still prove useful in some cases, and the " effective " articulation test which would be used for obtaining circuit ratings.

The question now arises as to how values of effective articulation should be obtained, and this problem can be divided into two parts :—

(*a*) The determination of effective calling volumes under service conditions.

(*b*) The modifications of the constant volume technique required to give effective articulation values.

With regard to (*a*), we have to study the effect on the calling volume of the various factors such as room noise at the talking and listening end, line noise, attenuation and cut-off frequency. Obviously the effect of these factors is required under service conditions so that measurements of calling volume must be made on various types of working circuit and conditions. However, it is difficult to control the various factors under service conditions, so that the best solution to the problem will probably be obtained by combining a series of laboratory tests with the service tests. In the laboratory, conversations will be carried on over circuits which simulate as nearly as possible service conditions but in which the various factors can be changed separately or together. Measurements of calling volume will then enable the effect of the different factors to be obtained when operating alone or in various combinations.

These laboratory tests combined with similar tests on a number of circuits under working conditions should allow the whole range of possible variations to be covered.

Having obtained the effect on the calling volume of the different factors we have then to apply these results to the articulation test. It is suggested that probably the best way of controlling the calling volume in articulation testing is to use an artificial mouth. This consists of a microphone coupled to a loudspeaker mechanism, the whole being equalised so that the overall frequency characteristic is flat. The operator then talks into the microphone of the artificial mouth and the loudspeaking device is placed in front of the transmitter of the circuit being tested. By adjusting the gain of the amplifier the device can be used to deliver various levels to the transmitter while the operator maintains the usual constant calling volume.

As already pointed out, there are two effects to take into account; the first is the fact that certain circuit conditions produce an effect on the average calling volume of all subscribers, while the second is the fact that for any given set of circuit conditions the actual calling volumes of different subscribers are distributed above and below the average value.

Suppose that for a given set of circuit conditions we took a large number of subscribers and measured the calling volume of each. Suppose also that for the same circuit conditions we make a series of articulation tests using in turn the calling volume of each of the subscribers. Then the average of all these articulation values will be the average articulation for all the subscribers. If now we work out the average calling volume for all the subscribers and take an articulation test using this average calling volume, we shall get a value of articulation which in general is not the same as the average articulation for all the subscribers. The reason for this difference is that usually there is not a linear relation between articulation and calling volume, and it is only when a linear relation exists between these two quantities that the average articulation is the same as the articulation corresponding to the average calling volume.

In general, therefore, it is not sufficient to determine the average calling volume for a given set of circuit conditions and then use this volume for the articulation test. One way of taking this effect into account would be to let each member of the articulation crew call at his natural volume instead of at a fixed volume. There are two objections to this, however. In the first place the natural calling volume of a tester when taking part in an articulation test is not necessarily the same as it would be on the same circuit during an ordinary two-way conversation. In the second place, the number of testers used in an articulation crew is generally too few to give a true average. It seems better, therefore, for the crew to call always at a fixed volume and then to obtain the necessary variations in calling volume by means of the artificial mouth. If a crew of, say, five is used and each calls in turn to the remaining four, then if two complete tests are made for each case, there will be ten callers, each of which may, if necessary, be given a different calling volume by means of the artificial mouth. By suitably choosing the different calling volumes it is easy to obtain the correct average value of articulation. In cases where the curve between articulation and calling volume is known to be linear it is, of course, unnecessary to adopt the above procedure.

The two modifications to be made to the " constant volume " articulation test in order to obtain values of " effective " articulation are thus :

(*a*) The average calling volume adopted will not be constant for all tests but will be adjusted for each test according to the particular circuit conditions existing in that test.

(*b*) The different members of the articulation crew will not all call with the average calling volume mentioned under (*a*) but each will be allotted a different value so that while the average value in the average calling volume determined from (*a*), the dispersion of the individual results is arranged to simulate that occurring in practice.

Question No. 26. Subscribers' Sets with Loudspeaking Receivers (Category A2). 4th C.R.
(Continuation of Transmission Question No. 34 of 1935/1936.)

Conditions to fix for subscribers' sets liable to be used on international calls and which contain either loudspeaking receivers, or broadcasting type microphones with associated amplifier.

Question No. 27. Reference Equivalent of Subscribers' Sets (Category A_1). 4th C.R.
(Continuation of Transmission Question No. 35 of 1935/1936.)

What are the best methods of measurement for determining the reference equivalent of microphones and receivers ?

Note.—Measurements of transmitting and receiving efficiency carried out on similar subscribers' apparatus, by similar methods but in different countries and with different crews, have given somewhat different results. It appears desirable to study these differences and to endeavour to eliminate or reduce them.

4. List of Questions of Operating and Tariffs, the study of which is to be undertaken or continued by the 6th and 7th C.R.'s in 1936 and 1937 and by the Mixed Committee for the General European Toll Plan in 1937 and 1938.

Question No. 1. Statistics of International Telephone Traffic (Category A2). 6th and 7th C.R.'s.

Is it not advisable to restrict the statistics of international telephone traffic, published by the C.C.I.F. in accordance with Recommendation No. 60, to cases of very heavily loaded circuits (having more than 80 unit calls per day) and on which the delay exceeds ¼ hour, that is to say, to instances where it is a case of justifying the putting into service of new circuits over those routes, it being understood that it would be left, if necessary, for the terminal exchange on the international line to establish traffic statistics and a record of the delay during the busy period ?

Note.—The quarterly statistics of telephone traffic and delays during the busy period (Recommendation No. 60) entail an amount of work which is not commensurate with the service obtained. The statistics show that owing to the present considerable development of the European telephone network, the delay, in the great majority of cases, is less than 10 minutes during the busy hours and that the traffic load per circuit is below the permissible limit. Also in spite of the care taken (in accordance with Recommendation No. 60) in establishing the statistical data, the results are still only of an accidental nature.

Question No. 2. Rate Reduction for Long Calls (Category A2). 7th C.R.

(*a*) In view of the interest that Administrations and Operating Companies have in popularising telephone traffic in general and calls of long duration in particular, would it be advisable, in principle, to adopt a tariff progressively decreasing with the length of the conversation, the minutes in excess of a fixed number determining the amount of the reduction in the rate ?

(*b*) If the above principle is accepted what reduction should be made in the case of :—
(1) Ordinary calls ?
(2) Subscription calls ?

Question No. 3. Methods of giving Toll Calls Priority over Local Calls (Blocking the Subscriber from the Toll Office) (Category A2). 6th C.R.

Should the recommendation (White Book, Vol III, pp. 185 and 186, English Edition 1934, p. 258) as to methods of giving toll calls priority over local calls be modified so that the setting up of international calls suffers the least possible delay, and that the technical arrangements for doing this provided by the local and toll exchanges should be simplified as much as possible ?

Note.—In studying this question, manual as well as automatic systems should be taken into consideration.

Question No. 4. General Toll Plan for Europe (Category A2).

What general guiding principles should be recommended in order to facilitate agreement between the various Administrations and Operating Companies in Europe as to normal, auxiliary and emergency routes (Telephone Regulations, Madrid International Telecommunication Convention, Art. 3, Para. 3)?

Would it be possible to arrange for a General Toll plan for Europe by means of such guiding principles ?

Note.—The study of this question has been delegated to a Mixed Committee consisting of representatives of both the operating and technical services as follows :—

President : Mr. Höpfner (Germany).

Members representing the operating side :—

Germany	Mr. Ehlers.
Belgium	Mr. Fossion.
France	Mr. Debry.
Great Britain	Mr. Gomm.
Hungary	Dr. Havas.
Sweden (and Scandinavia)	Mr. Halling.
Switzerland	Mr. Moeckli.

Members representing the technical side :—

Germany	Mr. Gladenbeck, Mr. Oehlen.
Denmark	Mr. Holmblad.
France	Mr. Malézieux.
Great Britain	Capt. Timmis, Mr. Chamney.
Hungary	Dr. Tomits.
Poland	
Rumania	Mr. McCurdy.
Czechoslovakia	Mr. Stowasser.
U.S.S.R.	Prof. Lapirov-Skoblo.
Technical Consultant	Dr. Osborne (A. T. & T. Co.).
Secretary	Mr. Parmentier.

Question No. 5. Rapid Telephone Service (Category A2). 6th and 7th C.R.'s.

In view of the recent progress in the technique of automatic switching, and in order to reduce the cost of establishing international calls, is not this the time to consider the possibility of a more speedy switching of international traffic, as is done on the *internal* traffic of various countries ?

If so, it would be necessary to stipulate, among other requirements, that if the international telephone traffic warrants it, circuits should be separately allocated :—

(*a*) For routing direct outgoing traffic.

(*c*) For routing the rest of the traffic, and if the subscribers in these localities are served by an automatic system, the Administrations and Operating Companies concerned could arrange *that the operator in one of these localities could dial the called subscriber of the other locality with which she is in direct communication.*

Circumstances permitting, the above mentioned direct selection could be extended to telephone networks the subscribers of which can be automatically reached, via the latter locality mentioned above.

It will also be necessary to modify the Instruction for Operators on the European International Telephone Service in order to arrange the immediate changeover, at certain times agreed by the international terminal exchanges concerned from delay operation to no delay operation (traffic direct, demand service, combined line and recording operation, etc.).

Note.—In the study of this question, rates will also be considered.

Question No. 6. Deferred Calls (Category A2). 6th and 7th C.R.'s.

Is it not advisable to introduce in the international telephone service a new category of calls, that of deferred calls (at reduced rate) ? These calls would be requested before, say, 10 o'clock in the morning, to materialise later, say during office hours in the afternoon *at a time when on the circuit concerned there are no calls on hand at the full rate.* This category of calls would be useful to telephone users for handling non-urgent matters needing a verbal exchange of ideas rather than an exchange of letters. The use of these calls during the evening or the night would not be arranged for, because the majority of business houses are closed at those times.

Note.—This idea does, however, present difficulties in its realisation and in the effect which it will have on the calls at full rate. Fluctuation of international traffic results, now even more than in the past in many periods of light traffic, during which deferred calls could be set up, but these periods vary in different countries. On the other hand it is perhaps not impossible that a more equal distribution of the traffic throughout the day might be obtained in this way, which might lead to economy of working in some instances.

Question No. 7. Determination of the Busy Hours for Calls by Subscription (Category A2). 6th and 7th C.R.'s.

In the new recommendation on subscription calls (Part II Rates) it is stated that the busy hours may be determined by the Administrations or Operating Companies concerned. Would it not be better to retain the ruling given in Article 114 (*a*) of the Instructions to Operators according to which the busy hours are fixed by agreement between the terminal exchanges concerned ?

Note.—In view of the frequent variations in the volume of traffic, of changes between winter time and summer time, etc., it would seem more suitable to leave the determination of the busy hours to the exchanges directly concerned.

Question No. 8. Report Charges in the International Radiotelephone Service (Category A_1). 7th C.R.

Is it not advisable to revise Recommendation No. 54 in connection with the application of report charges in the case of calls using international radiotelephone circuits, in view of the fact that this recommendation has not been generally applied ?

If so, how should it be revised ?

Revised Question No. 9. Calls with préavis or with avis d'appel (Category A2).

(*a*) Is it not desirable that calls with préavis or avis d'appel may be permitted to be requested one or two days in advance ?

(*b*) Seeing that the case of a no-reply in the reception of a préavis call is similar to a no-reply in an ordinary call, and that in the latter case no charge is made, would it not be equitable to forego the charge for one minute's conversation authorised by the Telephone Regulations (Madrid Convention 1932) subject to agreement between the operating authorities concerned ?

Note.—If the answer is in the affirmative it will be necessary to suggest to the Cairo Conference in 1938 that paragraph 200 of the Telephone Regulations should be amended accordingly.

Question No. 10. Subscription Calls (Category A2). 6th and 7th C.R.'s.

For unforeseen reasons the holder of an international telephone subscription may be led to forego one of the daily calls provided for in his contract. In these exceptional circumstances should not the call contracted for and not used be charged at the price of one minute's conversation, provided that the subscriber has given at least four hours' notice ?

Question No. 11. Agreement on the Chargeable Duration of a Call (Category A2). 6th and 7th C.R.'s.

Present instructions (Article 74 of Instructions to International Operators) prescribe that in the agreement between the operators after each call, the category of the call must be indicated except in the case of an ordinary call. Could not this be abandoned since the category of the call has already been given when the request for the call was transmitted ?

Question No. 12. Rates (Category A2).

In order to help the uniformity of international telephone charges is it not opportune to insert in the Telephone Regulations (Madrid Convention 1932) under Terminal Charges a provision on similar lines to that contained in paragraph 150 of the said Regulations which specifies that " under similar conditions of transit any one Administration or Operating Company applies the same transit charges " ?

Question No. 13. Rates for international broadcasts taking place over a different line from that used for ordinary commercial telephony (Category A2). 7th C.R.

In Part II " Rates " of C.C.I.F. Recommendation No. 50, " Radio Broadcast Transmissions," will be found the following paragraph :—

" When, for a certain set-up, owing to the lack of direct music circuits in one of the countries traversed by the ordinary long-distance telephone circuits, use is made in this section, of a music circuit which passes through a country or countries other than those on the normal route, the charge made is based on the sum of the terminal and transit charges of the various countries traversed by the line used."

Should not this paragraph be revised to make it clear that it also applies :—

1. To the case where the direct music circuit is not available, being in use for another broadcast at the time.
2. To the case where no direct music circuit exists.

Note.—The conditions under which an emergency circuit is used for ordinary telephone calls are laid down in paragraph 31 of the Telephone Regulations (International Telecommunication Convention, Madrid, 1932) ; by analogy it would seem that an indirect broadcast circuit can only be considered to be an emergency circuit in case of breakdown or of a serious fault occurring on the direct broadcast circuit.

The fact that the direct broadcast circuit is occupied at the time for the transmission of another broadcast does not appear to constitute a case of " serious fault." In consequence in such a case it is the paragraph of C.C.I.F., Recommendation No. 50, quoted above, which appears applicable and not the two subsequent paragraphs which refer to rates for ordinary telephone calls over an emergency route.

PART V.

COMPOSITION OF THE COMMISSIONS OF RAPPORTEURS OF THE C.C.I.F. IN 1937 AND 1938.

1st C.R. entrusted with questions in regard to the protection of telephone lines against interference from electric power installations:—

GERMANY: Dr. P. Jäger (*Chief Rapporteur*) and Dr. H. Klewe.
AUSTRIA: Mr. Pfeuffer.
BELGIUM: Mr. Parfondry.
CHINA: .....
FRANCE: Messrs. Drouet and Collet.
GREAT BRITAIN: Mr. P. B. Frost.
ITALY: Mr. C. Albanese.
JAPAN: Mr. C. Asami.
MEXICO: Dr. Mauritz Vos.
POLAND: Mr. B. Jakubowski.
PORTUGAL: Mr. J. Matos E. Silva.
RUMANIA: Mr. B. H. McCurdy.
SWEDEN: Mr. Swedenborg.
CZECHOSLOVAKIA: Mr. J. Michalek.
U.S.S.R.: Prof. Lapirov-Skoblo.

2nd C.R. entrusted with questions covering the protection of cables against corrosion due to electrolysis or chemical action, and questions of the constitution of cable sheaths:—

FRANCE: Mr. Collet (*Chief Rapporteur*).
GERMANY: Dr. H. Klewe.
BELGIUM: Mr. Parfondry.
GREAT BRITAIN: Mr. P. B. Frost.
ITALY: Mr. A. Baldini.
JAPAN: Mr. A. Ishii.
POLAND: Mr. H. Pomirski.
U.S.S.R.: Prof. Azboukin.
URUGUAY: Dr. Lüschen.

3rd C.R. entrusted with certain questions of transmission and maintenance:—

GERMANY: Mr. K. Höpfner (*Chief Rapporteur*), Mr. F. Gladenbeck, Dr. H. Düll and Mr. W. Zerbel.
AUSTRIA: Mr. Heider.
BELGIUM: Mr. Haemers.
CUBA: Mr. P. E. Erikson.
DENMARK: Mr. N. E. Holmblad.
SPAIN: Mr. J. M. Clara Corellano.
U.S.A.: Dr. Morehouse.
FRANCE: Mr. Aguillon and Mr. Bélus.
GREAT BRITAIN: Mr. J. G. Hines, Mr. R. M. Chamney and Mr. R. H. Franklin.
ITALY: Mr. C. Albanese and Mr. F. Pepe.
JAPAN: Mr. K. Ohashi.
MEXICO: Dr. Mauritz Vos.
NORWAY: Mr. S. Rynning-Tönnesen.

HOLLAND: Mr. H. J. Boetje, Mr. J. Winkel and Mr. J. Tj. Visser.
POLAND : Mr. K. Dobrski.
PORTUGAL : Mr. C. G. S. Ribeiro.
RUMANIA : Mr. B. H. McCurdy.
SWEDEN : Mr. A. V. A. Holmgren.
SWITZERLAND : Dr. H. Keller.
CZECHOSLOVAKIA : Mr. J. Michalek.
U.S.S.R. : .....
URUGUAY : Dr. Lüschen.

4th *C.R. entrusted with certain questions of transmission :—*
GREAT BRITAIN : Mr. B. S. Cohen (*Chief Rapporteur*), Mr. A. C. Timmis and Mr. A. J. Aldridge.
GERMANY : Mr. K. Braun.
CUBA : Mr. L. C. Pocock.
U.S.A. : Mr. W. H. Martin.
FRANCE : Mr. Chavasse.
HUNGARY : .....
JAPAN : Mr. Matsumae.
MEXICO : Mr. F. Markman.
POLAND : Mr. W. Norvicki.
SWEDEN : Mr. Swedenborg.
URUGUAY : Dr. Lüschen.

5th *C.R. entrusted with certain questions of transmission :—*
FRANCE : M. Ph. Le Corbeiller (*Chief Rapporteur*).
GERMANY : Mr. W. Zerbel.
ARGENTINE : Mr. E. M. Deloraine.
CHILE : Mr. E. M. Deloraine.
DENMARK : Mr. N. E. Holmblad.
SPAIN : Mr. J. M. Clara Corellano.
U.S.A. : Dr. Morehouse.
GREAT BRITAIN : Mr. A. J. Gill.
ITALY : Mr. G. Bleiner.
JAPAN : Mr. D. Arakawa.
HOLLAND : Mr. J. Tj. Visser.
POLAND : Mr. Cz. Rajski.
U.S.S.R. : .....

6th *C.R. entrusted with questions of exploitation :—*
BELGIUM : Mr. Fossion (*Chief Rapporteur*).
GERMANY : Mr. K. Ehlers.
CHINA : .....
DENMARK : Mr. M. Gredsted.
SPAIN : Mr. J. M. Clara Corellano.
U.S.A. : Dr. Morehouse.
FRANCE : Mr. Debry.
GREAT BRITAIN : Mr. W. H. Weightman and Mr. G. W. Gomm.
HUNGARY : Dr. Havas.
ITALY : Mr. Regnoni.
JAPAN : Mr. T. Kobayashi.
MEXICO : Mr. B. Wahlquist.

NORWAY : Mr. Wahl.
HOLLAND : Mr. R. Santing.
POLAND : Mr. Stanislaw Debicki.
RUMANIA : Mr. J. J. Parsons.
SWEDEN : Mr. K. E. Halling.
SWITZERLAND : Mr. A. Möckli.
CZECHOSLOVAKIA : Mr. F. Matous.
U.S.S.R. .....
URUGUAY : Dr. Lüschen.

7th C.R. entrusted with questions of tariffs :—
BELGIUM : Mr. Fossion (*Chief Rapporteur*).
GERMANY : Mr. K. Ehlers.
AUSTRIA : Mr. Œstreicher.
CHINA : .....
DENMARK : Mr. M. Gredsted.
SPAIN : Mr. J. M. Clara Corellano.
U.S.A. : Dr. Morehouse.
FRANCE : Mr. Debry and Mr. Rigollet.
GREAT BRITAIN : Mr. W. H. Weightman and Mr. S. T. Keyte.
HUNGARY : Dr. Havas.
ITALY : Mr. Regnoni.
JAPAN : Mr. T. Kobayashi.
MEXICO : Mr. B. Wahlquist.
NORWAY : Mr. H. Wahl.
HOLLAND : Mr. R. Santing.
POLAND : Mr. Stanislaw Debicki.
PORTUGAL : Mr. O. Saturnino.
RUMANIA : Mr. J. J. Parsons.
SWEDEN : Mr. K. E. Halling.
SWITZERLAND : Mr. A. Möckli.
CZECHOSLOVAKIA : Mr. F. Matous.
U.S.S.R. : .....

MIXED COMMITTEE FOR THE GENERAL EUROPEAN TOLL PLAN

PRESIDENT : Mr. K. Höpfner, Germany.

Representatives of the operating services :—
GERMANY : Mr. K. Ehlers.
BELGIUM : Mr. Fossion.
SPAIN : .....
FRANCE : Mr. Debry.
GREAT BRITAIN : Mr. G. W. Gomm.
HUNGARY : Dr. Havas.
SCANDINAVIA : Mr. K. E. Halling.
SWITZERLAND : Mr. Möckli.

Representatives of the technical services :—
GERMANY : Mr. F. Gladenbeck and Mr. P. Oehlen.
DENMARK : Mr. N. E. Holmblad.

FRANCE : Mr. Malézieux.
GREAT BRITAIN : Mr. A. C. Timmis and Mr. R. M. Chamney.
HUNGARY : Dr. Tomits.
POLAND : .....
RUMANIA : Mr. B. H. McCurdy.
SWEDEN : Mr. Holmgren.
CZECHOSLOVAKIA : Mr. Stowasser.
U.S.S.R. : Prof. Lapirov-Skoblo.

Technical Consultant:—
U.S.A. : Dr. Osborne (A.T.&T.Co.).
Secretary : Mr. Parmentier.

PERMANENT SUB-COMMITTEE ON MAINTENANCE

President : Mr. K. Höpfner, Germany.
GERMANY : Dr. H. Düll.
FRANCE : Mr. Parmentier.
GREAT BRITAIN : Mr. R. H. Franklin.
HOLLAND : Mr. Visser.
RUMANIA : Mr. B. H. McCurdy.
SWEDEN : Mr. Nordström.
SWITZERLAND : Dr. Keller.

PART VI.

LIST OF C.C.I.F. RECOMMENDATIONS IN FORCE ON 1st JANUARY, 1937.

A. PROTECTION

	English Page.		French	
	1934	1936	Vol.	Page.
1. PROTECTION OF TELEPHONE LINES AGAINST INTERFERENCE.				
Recommendation No. 1. Guiding Principles concerning the measures to be taken to protect telephone lines against the interfering effects of heavy current or high tension systems ...	—	28	II bis	7, 9
Recommendation No. 2. Use of electrostatic formulae for determining the electric induction from an alternating current line in a telephone circuit	—	32	II bis	15
Recommendation No. 3. Calculation of the effects caused by short circuit current	—	33	II bis	15
Recommendation No. 4. Psophometric voltage. Psophometric E.M.F. Equivalent disturbing voltage, etc.	—	33	II bis	16
Recommendation No. 5. Objective measurement of line noise ...	—	34	II bis	18
Note.—Specification of the principle and method of use of psophometers employed on commercial telephone circuits	—	35	II bis	19
Recommendation No. 6. Technical information on the psophometers at present in use	—	38	II bis	25
Recommendation No. 7. Objective measurement of equivalent interfering voltage	—	39	II bis	25
Recommendation No. 8. Calculation of the psophometric E.M.F. due to ripples in the case of continuous current traction lines ...	—	39	II bis	27
Recommendation No. 9. Distributed unbalance of a telephone line with respect to earth ; noise ratio (coefficient de sensibilité)	—	40	II bis	28
Recommendation No. 10. Localised unbalance with respect to earth	—	40	II bis	28
Recommendation No. 11. Reduction of the disturbing voltage of rectifiers	—	41	II bis	30
Recommendation No. 12. Tests in connection with rectifiers ...	—	41	II bis	31
Recommendation No. 13. Effect of transpositions in a power line	—	42	II bis	32
Recommendation No. 14. Devices for protecting operators against acoustic shock	—	42	II bis	32
Recommendation No. 15. Earthing a long distance telephone circuit in cable	—	43	II bis	33
Recommendation No. 16. Connection of a public telephone system to telephone circuits associated with power installations ...	—	43	II bis	34
Recommendation No. 17. Principles of protection	—	44	II bis	36
Recommendation No. 18. Ideal protective device	—	45	II bis	37
Recommendation No. 19. Exact determination of the principal characteristics of protective devices	—	45	II bis	38
Note I.—Principal characteristics of protective devices	—	46	II bis	38
Note II.—Tabular representation of protective devices used in the telephone installations of different countries, etc.	—	48	II bis	43
2. PROTECTION OF TELEPHONE CABLES AGAINST ELECTROLYTIC CORROSION				
Recommendation No. 1. Information on the effects of electrolysis and collaboration with the interested organisations	—	53	II bis	62
Recommendation No. 2. Committee for the revision of Recommendations concerning measures for the protection of cables against electrolytic corrosion	—	54	II bis	63
Note.—Main modifications to be made to the " Recommendations for protection of cables against electrolytic corrosion "	—	55	II bis	66
Recommendation No. 3. Calculation of rail voltage with regard to earth and the limitation of this voltage		56	II bis	68
Recommendation No. 4. Electric drainage and insulating joints	—	57	II bis	70
Proposed recommendations concerning measures to protect cables against electrolytic corrosion	—	59	II bis	74
A. General	—	60	II bis	75
B. Protective measures applicable to electric traction networks	—	61	II bis	77
C. Protective measures applicable to underground cable networks	—	64	II bis	83
D. Protection by means of electric drainage	—	65	II bis	86
Appendix I. Principle of the method to be followed for calculating the distribution of return currents in a tramway system ...	—	66	II bis	88

	English Page.		French	
	1934	1936	Vol.	Page.
Appendix II. To the Recommendations concerning the measures to be taken for the protection of cables against electrolytic corrosion	—	72	II bis	97
(1) Measurements of the stray current intensity	—	72	II bis	97
(2) Measurements of the differences of potential and drop in voltage	—	75	II bis	101
(3) Measurements of the resistance of rail joints	—	76	II bis	102
3. PROTECTION OF TELEPHONE CABLES AGAINST CHEMICAL CORROSION				
Proposed recommendations concerning measures for the protection of cables against corrosion due to chemical action	—	77	II bis	105
Appendix. Method for determining whether corrosion is electrolytic or chemical	—	78	II bis	107
B. CONSTITUTION OF TELEPHONE CABLE SHEATH				
Recommendation No. 1. Impurities in the constituents of cable sheath	—	79	II bis	109
Recommendation No. 2. Elasticity of cable sheaths	—	79	II bis	110
C. TRANSMISSION				
1. DEFINITIONS IN TELEPHONE TRANSMISSION ...	165	—	I bis	49
Transmission units: Nepers, decinepers, bels, decibels	165	—	I bis	49
Conversion table: Nepers to decibels	166	—	I bis	50
Conversion table: Decibels to nepers	166	—	I bis	51
Frequency	167	—	I bis	53
Impedances	167	—	I bis	53
Transfer or propagation constants; losses or gains; phase distortion, echo, singing point, stability	167	—	I bis	54-61
Distortion	172	80	I bis	61
Levels	173	80	I bis	62
Noise	173	—	I bis	63
Crosstalk, crosstalk coupling	174	—	I bis	65
Psophometric electromotive force	175	—	I bis	65
Signal to noise ratio	175	80	I bis	66
Unbalances (Dyssymétries)	175	—	I bis	68
Unbalances (Déséquilibres)	176	—	I bis	70
Transpositions	177	—	I bis	73
Acousto-electric index	178	—	I bis	74
Relative efficiency of a transmitting system E^1 with reference to another transmitting system E^{11} (or of a receiving system R^1 with reference to another receiving system R^{11})	178	—	I bis	74
Speech power (volume)	179	—	I bis	75
Reference equivalents	180	—	I bis	78
Side tone	180	—	I bis	79
Reference equivalent of side tone	181	—	I bis	80
Articulation or intelligibility	181	—	I bis	81
Repetition rate	182	—	I bis	82
Effective transmission equivalent	182	—	I bis	82
Frequency distortion transmission impairment	182	—	I bis	82
Noise transmission impairment	183	—	I bis	83
Names of various transmission testing sets: transmission (level) measuring set; gain measuring set; transmission measuring set, noise meter, sound meter, crosstalk meter	183	—	I bis	83
Graphical symbols for telephony	183	—	III	45
2. RECOMMENDATIONS OF PRINCIPLE CONCERNING TELEPHONY TRANSMISSION	184	82	I bis	84
General telephone switching plans	184	82	I bis	84
Criterion of the quality of transmission in international telephone service	185	84	I bis	88
Effective transmission equivalent	185	84	I bis	89
Table showing the relations between various electrical characteristics influencing the quality of electrical communication	186	—	I bis	91
Note 1.—Provisional values of impairment in transmission quality due either to line noise or restriction in the frequency band effectively transmitted over the circuit	187	85	I bis	91
Note 2.—The present state of the question of effective transmission equivalents in the United States of America, Great Britain,				

	English Page		French	
	1934	1936	Vol.	Page.
Germany and Rumania, and Programme of tests to be made at the SFERT laboratory on " effective transmission equivalent " ...	194	91	I bis	103-133
Note 3.—Effect of room noise on telephone transmission quality ...	—	97	I bis	117
	—	104	I bis	128
REFERENCE EQUIVALENTS :—				
Practical limits for the total reference equivalent in an international communication between two subscribers	197	105	I bis	133
Practical limits for the reference equivalent of the national sending and receiving systems in an international communication between two subscribers	198	—	I bis	133
Definition of " conventional via terminals " of an international circuit	198	—	I bis	134
Practical limits of the reference equivalent of an international communication between two operators or between an operator and a subscriber	199	—	I bis	134
Frequency band to be transmitted	200	—	III	80
Time of propagation	200	105	I bis	137
Transient phenomena	201	106	I bis	138
Frequency of signalling currents	201	106	I bis	139
Guiding principles in the establishment of essential clauses of a specification for :—				
I. Voice frequency ringers	202	—	I bis	140
II. Transmission of dialling impulses over international circuits	—	106	I bis	142
III. Voice frequency signalling in automatic telephone service ...	—	107	I bis	142
Choice of a single frequency for routine measurements	203	106	III	85
Use of international circuits for the relaying of radio-broadcast transmissions	203	—	III	87
Compensation of temperature effects on long circuits	204	—	III	87
Note.—Guiding principles concerning compensation of the effects of temperature variations	204	—	III	88
Appendix I. Switching programme in Germany	206	—	III	92
Appendix II. Switching programme in Great Britain	210	—	III	100
Appendix III. Switching programme in France	220	—	III	117
Appendix IV. Switching programme in the United States of America	222	—	III	122
Appendix V. Switching programme in Holland	224	—	III	126
3. GENERAL RULES CONCERNING THE MAKE-UP OF TRANSMISSION SYSTEMS	226	—	I bis	144
Section 1. Ordinary Telephony	226	—	I bis	144
General conditions which international circuits used for ordinary telephony must fulfil	226	—	I bis	144
Make-up of an international telephone circuit...	226	—	I bis	145
Impedance	226	—	I bis	145
Terminal Equivalent	227	107	I bis	146
Calculation of the minimum equivalent admissible in service ...	—	108	I bis	147
Frequency distortion	227	—	III	132
Relative levels	—	109	I bis	150
Echo effects	—	112	I bis	155
Stability	—	113	I bis	157
Propagation time	232	113	I bis	157
Transient phenomena, crosstalk and other disturbances	—	113, 114	I bis	157
Line noise	233	—	I bis	159
Non-linear distortion	233	114	I bis	159
Notes on the use of different types of loading	234	—	I bis	160
Note on Echo-Suppressors	—	115	I bis	165
1. Various types of echo-suppressors	—	115	I bis	165
2. Sensitivity	—	115	I bis	165
3. Operating time of echo-suppressors	—	116	I bis	167
4. Hang-over time of echo-suppressors	—	116	I bis	168
5. Partial closing time of echo-suppressors	—	116	I bis	168
Appendix 1. Calculation of the minimum admissible equivalent for a circuit not equipped with echo-suppressors	—	117	I bis	169
Appendix 2. Calculation of the minimum admissible equivalent from the point of view of echo for four-wire circuits equipped with echo-suppressors and for a combination of four-wire circuits equipped with echo-suppressors and two-wire circuits	—	119	I bis	173
Phantoming of international circuits	—	115	III	146
Interconnection of four-wire circuits	—	115	III	147
Section II. Carrier current telephony	236	—	I bis	180
A. Multiple carrier current telephony	236	—	I bis	180
General characteristics of multiple carrier telephone systems ...	237	—	I bis	180
General	237	—	I bis	181

	English Page		French	
	1934	1936	Vol.	Page.
Equivalent and levels	237	—	I bis	182
Frequency distortion	238	—	I bis	183
Impedance	238	—	I bis	183
Crosstalk and other disturbances	238	123	I bis	183
Monitoring and adjustment	239	—	I bis	184
Signalling	239	—	I bis	185
Interconnections and echoes	239	—	I bis	185
Low frequency channels	239	—	I bis	185
Draft of model questionnaire for preliminary information in regard to existing open wire lines and offices, to be obtained by Telephone Administrations wishing to establish carrier current telephone installations	240	—	I bis	186
General characteristics of multi-channel carrier telephone systems for Cables with light or very light loading	—	124	I bis	187
1. Circuits providing one carrier channel in addition to the ordinary voice channel	—	124	I bis	187
2. Circuits providing 2, 3 or 4 carrier channels in addition to the ordinary voice channel	—	124	I bis	187
Appendix. Non-linear crosstalk in carrier current systems	—	125	I bis	188
B. Two-band telephony	240	—	III	154
General characteristics of a telephone system utilising two frequency bands	240	—	III	154
General	241	—	III	154
Possibilities of the application of the two-band telephone system	241	—	III	155
Technical conditions which the terminal apparatus must fulfil	242	—	III	157
(*a*) Bands of frequencies effectively transmitted	242	—	III	157
(*b*) Carrier frequency	242	—	III	157
Attenuation and gain	242	—	III	158
(*a*) The two-band section including terminals between two toll exchanges	242	—	III	158
(*b*) Two-band sections forming part of a long four-wire section	—	243	III	158
Regulation of the gain	243	—	III	159
Impedance	243	—	III	159
(*a*) Two-band section between two toll exchanges	243	—	III	159
(*b*) Two-band sections forming part of a long four-wire section	243	—	III	159
Non-linear distortion	243	—	III	159
Crosstalk	244	—	III	159
Conditions imposed upon a complete two-band telephone system	244	—	III	160
Section III. Radio-broadcast transmission	—	126	I bis	191
Electrical conditions to be considered as a criterion for the good condition of lines for relaying radio-broadcast transmission	247	—	I bis	191
A. General characteristics	247	—	I bis	191
Frequency band effectively transmitted	247	—	I bis	191
Power transmitted	247	126	I bis	191
Maximum volume	247	126	I bis	192
Non-linear distortion	247	—	I bis	192
Transient phenomena	—	126	I bis	192
Compensation for temperature variations	247	—	I bis	193
Crosstalk	247	—	I bis	193
Noise	248	—	I bis	193
B. Method of adjustment	248	127	I bis	194
Point of origin	248	—	I bis	194
Adjustment of levels	248	—	I bis	195
Maximum instantaneous voltage during a radio-broadcast transmission	249	—	I bis	195
Volume	249	—	I bis	195
Method of adjustment for anti-distortion	249	—	I bis	196
Permissible variations in the output levels of a repeater as a function of frequency	250	—	I bis	197
Station not a frontier station	250	—	I bis	197
Frontier station	250	—	I bis	198
Adjustable Correctors	—	127	I bis	199
C. Radio Diffusion	—	127	I bis	199
Section IV. Picture Transmission	250	—	I bis	199
Picture transmission over telephone circuits	250	—	III	173
Circuits to be used	250	—	III	173
Equivalents and levels	251	—	III	174
Frequency distortion	251	—	III	175
Transient phenomena	251	—	III	175
Crosstalk and other disturbances	252	—	III	176
Stability	252	—	III	176
Supervision	252	—	III	176

	English Page.		French	
	1934	1936	Vol.	Page.
4. RECOMMENDATIONS CONCERNING SUBSCRIBERS' INSTALLATIONS, LOCAL LINES AND CENTRAL TELEPHONE EXCHANGES	253	—	I bis	200
Section 1. Subscribers' lines and instruments	—	128	III	177
Systems for recording messages	—	128	III	177
Conditions to be fulfilled by subscribers' installations using loud speakers, international circuits	—	129	III	177
Section II. Urban lines and exchanges	254	—	III	180
Conditions which circuits between international terminal exchange and urban exchanges should fulfil	254	—	III	180
General conditions which should be fulfilled by a new Bourse Exchange as regards the use of international circuits	255	—	III	181
A. The case where long distance circuits are directly connected to a Bourse Exchange	255	—	III	181
B. The case where calls to or from the Bourse Exchange are established over normal circuits	256	—	III	182
Section III. Long Distance exchanges	256	—	III	183
Comparative advantages of cord circuit repeater positions and terminal repeaters, associated with artificial lines	256	—	III	183
Conditions to be satisfied by cord circuit repeater positions from the point of view of facilities for regulation of the repeater as well as for supervision, and charging of calls	257	—	III	183
Conditions to be satisfied by international positions as regards the type of operator's set and the transmission losses due to the operator listening on the line	257	—	III	184
Methods of giving toll calls priority over local calls (Blocking the subscriber from the toll office)	258	—	III	185
Conditions which service observing positions should fulfil for international telephone traffic	258	—	III	186
Conditions which must be fulfilled by equipment used for conference calls	259	—	III	188
5. RECOMMENDATIONS REGARDING REPEATER STATIONS	261	—	III I bis	191 215 191
Position of repeater stations	261	—	III	215
General characteristics of the repeaters	261	—	I bis	
1. Repeaters for two-wire circuits (ordinary telephony)	261	—	I bis	215
Type	261	—	I bis	215
Amplification	261	—	I bis	215
Impedance	262	—	I bis	216
Monitoring	262	—	I bis	217
Crosstalk	262	135	I bis	217
Non-linear distortion	262	136	I bis	218
2. Repeaters for four-wire circuits (ordinary telephony)	263	—	I bis	218
Type	263	—	I bis	218
Amplification	263	136	I bis	219
Impedance	—	136	I bis	219
Monitoring	263	—	I bis	220
Crosstalk	264	136	I bis	220
Non-linear distortion	264	136	I bis	221
3. Repeaters for junction points between two cables having different transmission properties (ordinary telephony)	264	138	I bis	221
4. Repeaters used in broadcast transmission relays	265	—	I bis	223
Type	265	—	I bis	223
Amplification	265	—	I bis	223
Impedance	266	—	I bis	224
Listening device	266	—	I bis	224
Crosstalk	266	—	I bis	224
Output power	266	—	I bis	224
Absence of noise	266	—	I bis	224
Non-linear distortion	266	—	I bis	225
5. High frequency repeaters	266	—	I bis	225
Repeater valves	267	—		
Guiding principles concerning a specification for the supply of valves for telephone repeaters	267	136	I bis	226

	English Page. 1934	English Page. 1936	French Vol.	French Page.
6. RECOMMENDATIONS CONCERNING INTERNATIONAL LINES	269	—	III	205
Section I. Open wire lines	269	—	III	205
Loading of open wire lines	269	—		
Setting up of open wire lines	269	—	III	205
A. **Concerning the mechanical qualities**	269	—	III	206
B. **Concerning the electrical qualities**	270	—	III	206
Testing points on the international circuits	272	—	III	210
Supervision of the lines by means of patrol service	272	—	III	211
Use of aerial lines for broad frequency-band transmission	272	—	III	211
Note.—Setting up of open-wire lines	273	—	III	211
Note 1.—Calculation of the stability of a circuit open at both ends and having a single repeater in the middle	273	—	III	212
Note 2.—Balancing networks for repeaters permanently inserted in open-wire or mixed lines	275	—	III	216
Section II. Cables	277	—	III	220
1. General	277	—	III	220
General recommendations for cables allocated to international service	277	—	III	220
Star quad cable for long distance international circuits	277	—	III	220
Restricting the number of testing points in international cables	277	—	III	221
2. Aerial cables (nothing)	278	—	III	221
3. Underground cables (nothing)	278	—	III	221
4. Submarine cables	278	—	III	221
General characteristics of submarine telephone cables (to the exclusion of inter-continental cables of very long length)	278	—	III	221
A. **General conditions**	278	—	III	222
1. General	278	—	III	222
2. Level at the receiving end	278	—	III	222
3. Relative level at the sending end of the submarine cable	278	—	III	222
4. Attenuation of the cable, stability, crosstalk	279	—	III	223
5. Frequency distortion, transient phenomena	279	—	III	223
B. **Operating conditions**	279	—	III	224
1. Four-wire circuits	279	—	III	224
2. Two-wire circuits	279	—	III	224
3. Telephone connections with carrier currents	281	—	III	226
4. Use of phantom circuits	281	—	III	228
Section III. Mixed lines	281	—	III	228
Conditions to be fulfilled by mixed lines	281	—	III	228
Rules for the construction and loading of cables inserted in open-wire lines	282	—	III	229
Appendix Ia. Variation in the impedance of a circuit made up of open-wire lines of different construction	283	—	III	232
Appendix Ib. Variation in the impedance of a circuit made up of open-wire lines of different construction	283	—	III	233
Appendix Ic. Impedance of a circuit made up of two open-wire lines of 3 mm and 4 mm respectively	283	—	III	234
Real component	283	—	III	234
Imaginary component	283	—	III	235
Appendix II. Notes by Messrs. Siemens and Halske on the insertion of a section of cable in an open-wire line	284	—	III	236
Appendix III. Notes by the International Standard Electric Corporation regarding intermediate sections of cable inserted in open-wire lines	291	—	III	249
7. RECOMMENDATIONS CONCERNING THE OPERATION OF TELEPHONE AND TELEGRAPH CIRCUITS IN THE SAME CABLE	307	—	I bis	229
I. Simultaneous telegraphy and telephony over the same conductors	307	—	I bis	229
A. Infra-acoustic telegraphy	307	137	I bis	230
B. Ultra-acoustic telegraphy	308	137	I bis	232
C. Simultaneous telegraphy on phantom or super-phantom circuits	309	—	I bis	234
II. Simultaneous telegraphy and telephony over separate conductors	309	—	I bis	234
III. Multi-channel voice frequency telegraphy	309	—	I bis	234
IV. Private telegraph service between two telephone subscribers	310	138	I bis	236
Appendix 1. Conditions to be fulfilled by circuits used for infra-acoustic telegraphy exposed to power lines	—	138	I bis	237
Appendix 2. Conditions which circuits used for voice frequency carrier telephony	311	142	I bis	244

	English Page.		French	
	1934	1936	Vol.	Page.
Appendix 3. Modifications made in Great Britain to ringers on telephone circuits used for private telegraph service between two telephone subscribers	—	143	I bis	247
8. RECOMMENDATIONS CONCERNING THE CO-ORDINATION OF RADIO TELEPHONY AND TELEPHONE SYSTEMS	313	—	I bis	249
General conditions to impose upon radio telephone circuits ...	313	—	III	277
An instrument which allows the special operator located at the junction of a radio link and a metallic circuit to measure voice power	315	—	III	281
Protection of echo or reaction suppressors used on radio telephone circuits	315	—	III	282
Automatic volume regulators	—	143	I bis	249
Note1 .—Conditions to be fulfilled by the automatic volume regulator inserted at the junction between the land line and the radio link	316	144	I bis	249
Note 2.—B.P.O. } **Note 3.**—A.T. & T. }	—	144		
Interconnection of two radio links by means of a four-wire land circuit				
Conditions to be fulfilled by mobile telephone stations communicating with the public land network	— —	146 146	I bis III	251 286
Fading Corrections	—	145		
9. SPECIFICATIONS RECOMMENDED BY THE INTERNATIONAL TELEPHONE CONSULTATIVE COMMITTEE	319	146	I bis	255
Introduction	319	146	I bis	255
Section A. Essential clauses for a typical specification for the supply of a repeater section of an international cable and its constituent parts	320	—	I bis	256
Specification A.I. Essential clauses for a typical specification generally applying to factory lengths of international telephone cables of the quadded type	320	—	I bis	256
General	320	—	I bis	256
Raw materials	320	—	I bis	257
Copper conductors	320	—	I bis	257
Factory joints	320	—	I bis	258
Insulating paper	321	—	I bis	258
Sheathing and armouring material	321	—	I bis	258
Water-tightness test	321	—	I bis	258
Electrical characteristics	321	—	I bis	259
Conductor resistance	321	—	I bis	259
Insulation resistance	322	—	I bis	260
Dielectric strength	322	—	I bis	260
Effective capacity (alternating current)	322	146	I bis	261
Leakance constant	323	—	I bis	262
Capacity unbalance	323	146	I bis	262
Limits for capacity unbalance (in micro-microfarads for 230 metre lengths)	323	—	I bis	263
Specification A.II. Essential clauses for a typical specification of general application to loading coils for international telephone cables	324	—	I bis	265
Housing	324	—	I bis	265
Magnetic stability...	325	—	I bis	265
Inductance...	325	—	I bis	266
Direct current resistance	—	146	I bis	266
Effective resistance	—	147	I bis	266
Crosstalk	325	—	I bis	266
Insulation resistance	325	—	I bis	268
Dielectric strength	326	—	I bis	268
Unbalances to earth	326	—	I bis	268
Variation in inductance	326	—	I bis	269
Variation in resistance	326	—	I bis	269
Specification A.III. Essential clauses for a typical specification for repeater sections of loaded international telephone cable	326	—	I bis	269
General	326	—	I bis	269
Resistance unbalance	326	—	I bis	269
Insulation resistance	326	—	I bis	270
Average capacity regularity in the various loading sections ...	326	—	I bis	270
Impedance balance	326	—	I bis	270
Crosstalk	327	147	I bis	270
Near and far end crosstalk, two-wire circuits	327	—	I bis	271
Near end crosstalk, four-wire circuits, between opposite going four-wire groups	327	—	I bis	271
Far end crosstalk, four-wire circuits, between circuits transmitting in the same direction	327	—	I bis	271

	English Page.		French	
	1934	1936	Vol.	Page.
Types of lines in loaded cable	327	—	I bis	272
Loading coil spacing	327	—	I bis	272
Cut-off frequency	327	—	I bis	272
Speed of propagation	328	—	I bis	276
Impedance	328	—	I bis	276
Attenuation constant	328	—	I bis	276
Tables	328, 329 330	147		
Different ways in which two Administrations or Operating Companies can co-operate in the construction of a repeater section which crosses a frontier	331	147	I bis	276
Test of dielectric strength	—	148	I bis	278
Section B. Essential clauses for a typical specification for the supply of an intermediate or a terminal repeater station for an international cable and for its component parts	332	—	III I bis	310 282
Specification B.I. Essential clauses for a typical specification for the supply of line transformers	332	—	III I bis	310 282
Specification B.II. Essential clauses of a typical specification for the supply of repeaters	333	—	III I bis	312 284
Specification B.III. Essential clauses of a typical specification for terminating equipment	333	150	III I bis	312 284
Specification B.IV. Essential clauses for a typical specification for the supply of echo-suppressors	334	—	III I bis	— 285
Specification B.V. Essential clauses for a typical specification for the supply of power installations for repeaters	334	150	I bis	286
Specification B.VI. Essential clauses for a typical specification for the supply of repeater valves	334	—	I bis	286
Specification B.VII. Essential clauses for a typical specification for the supply of voice frequency ringers	334	—	I bis	286
Specification B.VIII. Essential clauses for a typical specification for the supply of repeater station cabling	—	150	I bis	287
10. STANDARDS OF TRANSMISSION				
Telephone transmission reference systems	344	—	I bis IV	289 11
Object of telephone transmission reference systems	344	—	IV	11
Various ways of setting up telephone transmission reference systems	344	—	IV	12
Conditions which should be fulfilled by the telephone transmission reference systems	344	—	IV	12
I. The master telephone transmission reference system (SFERT)	344	—	IV	12
II. Telephone transmission reference systems	345	—	IV	12
III. Working standards	349	—	IV	19
Recommendations regarding the calibration of reference systems and working standards	350	—	IV	20
(A) Normal adjustment of the master telephone transmission reference system (SFERT)	350	—	IV	20
(B) The normal calling intensity to be used in telephonometric tests	354	151	I bis	289
Appendix 1. Results of tests made by Germany, Great Britain, Rumania and A.T. & T. Co.	—	152	I bis	294
Appendix 2. Noise standard based on the Barkhausen effect used by the Japanese Administration as reference room noise in telephonometric tests	—	156	I bis	300
(C) Comparison of reference systems with the master reference system, and the periods at which such comparisons should be made	354	—	IV	30
(D) Initial comparison of working standards with the " SFERT " or with a reference system	354	—	IV	31
1. Comparison of a SETAC with the SFERT	355	—	IV	31
2. Comparison of a SETEM with the SFERT	358	—	IV	38
(E) Periodic calibration of standard instruments by the SFERT laboratory	361	—	IV	43
Appendix I. Description of a working standard using a carbon microphone (SETAC)	363	—	IV	46
Addendum to Appendix I. Essential clauses of a specification for the supply of repeating coils (toroidal coils)	365	—	IV	49
Appendix II. Description of a working standard using an electro-magnetic microphone (SETEM)	366	—	IV	52
11. TESTING METHODS				
Section I. Tests with alternating current	370	—	I bis IV	303 57
A. **Tests on quadripoles**	370	—	IV	57
1. Tests of effective attenuation or gain	370	—	IV	57
(*a*) First testing method	370	—	IV	57

	English Page		French	
	1934	1936	Vol.	Page.
(*b*) Second testing method (Method Z-R)	371	—	IV	59
(*c*) Variation of the first testing method by using an automatic level recorder	371	—	IV	59
2. Measurement of insertion loss or gain	373	—	IV	63
Application to the case of telephone exchange equipment ...	374	—	IV	63
3. Measurement of line transformers	377	—	IV	70
(*a*) Measurement of effective attenuation at voice frequencies	377	—	IV	70
(*b*) Measurement of the energy efficiency of line transformers used for low frequency signalling, 16 to 25 p : s	378	—	IV	71
B. Measurements made on telephone circuits	379	—	I bis	303
			IV	73
1. Measurement of the overall attenuation	380	—	IV	74
2. Measurement of absolute level, of level differences and of relative levels	381	—	IV	76
3. Measurement of repeater gain	382	—	IV	79
4. Measurement of impedance	384	—	IV	81
5. Measurement of balance attenuation, regularity attenuation, non-reflection attenuation and echo-current attenuation ...	384	—	IV	81
(*a*) Measurement of balance attenuation	384	—	IV	81
(*b*) Measurement of regularity attenuation	387	—	IV	87
(*c*) Measurement of non-reflection attenuation	387	—	IV	87
(*d*) Measurement of echo-current attenuation	388	—	IV	87
6. Determination of singing point and the measurement of stability or the singing margin	388	—	IV	87
(*a*) Determination of singing point	388	—	IV	87
(*b*) Measurement of the stability of a telephone circuit ...	390	158	I bis	303
(*c*) Measurement of the singing margin of a telephone circuit	391	158	—	—
(*d*) The use of the automatic level recorder for determining the singing point or the stability	391	—	IV	93
7. Verification of the battery voltages and the currents of the repeater battery supply; tests of repeater vacuum tubes ...	396	158	I bis	305
8. Measurement of distortion	396	—	IV	101
(*a*) Measurement of the frequency distortion of a telephone circuit from the curve of the overall attenuation plotted as a function of frequency	396	—	IV	101
(*b*) Measurement of the index of phase distortion of a telephone circuit	396	—	IV	102
(*c*) Measurement of the non-linear distortion of a telephone circuit	403	—	IV	114
(*c* 1) Measurement of harmonic distortion	403	—	IV	114
(*c* 2) Measurement of variation of attenuation as a function of amplitude (for a telephone circuit)	404	—	IV	115
9. Measurement of crosstalk	404	—	IV	116
(*a*) Measurement of near-end crosstalk	404	—	IV	116
(*b*) Measurement of far-end crosstalk	407	—	IV	120
Measurement of crosstalk between channels of a carrier system	409	—	IV	123
Electrical source for use in crosstalk measurements ...	409	—	IV	124
(A) Oscillator producing a sinusoidal current	410	—	IV	125
(B) Oscillator producing a complex current	411	—	IV	127
Receiver arrangement for use in the measurement of crosstalk	412	—	IV	130
Curve of the crosstalk attenuation plotted as a function of frequency	414	—	IV	132
Table showing how requirements are met by forms of crosstalk guarantee	416, 417	—	IV	134
10. Measurements of circuit noise	415	—	IV	136
(*a*) Subjective measurements	415	—	IV	136
(*b*) Objective method at present used	418	—	IV	138
11. Measurement of the degree of impedance unbalance (with respect to ground) and of capacity unbalances	419	—	IV	140
(*a*) Measurement of the degree of impedance unbalance (with respect to ground) of a telephone line	419	—	IV	140
Artificial line method	420	—	IV	141
Low resistance potentiometer method	420	—	IV	142
High resistance potentiometer method	420	—	IV	142
(*b*) Measurement of the degree of localised unbalance with respect to ground	421	—	IV	144
(*c*) Measurement of external capacity unbalances	422	—	IV	145
(*d*) Measurement of the effective unbalance of a telephone circuit with respect to neighbouring disturbing lines ...	423	—	IV	147

	English Page.		French	
	1934	1936	Vol.	Page.
(*d* 1) The Siemens and Halske apparatus (Geräuschun-symmetriemesser)	423	—	IV	148
(*d* 2) The Western Electric Apparatus (Noise ratio measuring set)	424	—	IV	149
12. Measurements carried out on circuits used for high frequency carrier	424	—	IV	150
(*a*) Measurements made when carrier current connections are established	424	—	IV	150
(*b*) Maintenance measurements on circuits used for carrier	427	—	IV	153
C. Measurements carried out on subscribers' telephone apparatus	428	—	IV	157
1. Measurement of the absolute efficiency of a transmitting or receiving system	428	—	IV	157
(*a*) Thermophone method	428	—	IV	157
(*b*) Rayleigh disc method	428	—	IV	159
(*c*) Compensation method	429	—	IV	159
2. Measurement of the distortion loss of a telephone set; read from the curve of absolute efficiency as a function of frequency	430	—	IV	161
3. Measurement of non-linear distortion of a telephone set ...	431	—	IV	163
(*a*) Measurements of the harmonic distortion of a microphone	431	—	IV	164
(*b*) Measurement of the variation of efficiency of a microphone or receiver as a function of the acoustic pressure or applied voltage	432	—	IV	166
Section II. Measurements by voice and ear (human or artificial)	433	—	I bis IV	306 167
A. Measurement of volume	433	—	IV	167
B. Measurement of reference equivalents and relative equivalents	433	—	IV	168
1. Measurement of true reference equivalents	433	—	IV	168
(*a*) Use of a working standard system of the SETAC type ...	434	—	IV	168
Two operator and bias-attenuation method	434	—	IV	168
Comparison of a solid back microphone with a solid back microphone standard	434	—	IV	169
Comparison of a Bell receiver with a Bell receiver standard	435	—	IV	171
Three operator without bias-attenuation method	437	—	IV	174
Comparison of a solid back microphone with a solid back microphone standard	437	—	IV	175
Comparison of a Bell receiver with a Bell receiver standard	439	—	IV	180
(*b*) Use of the SETEM type working standard	439	—	IV	180
Comparison of a transmitter with a transmitter standard type SETEM	440	—	IV	180
Comparison of a receiver with a receiver standard type SETEM	440	—	IV	181
Comparison of two complete systems	440	—	IV	182
Number of elementary balances	441	—	IV	182
Check testing of amplifiers	441	—	IV	183
(*c*) Precautions to be taken during telephonometric measurements	441	158	I bis	306
2. Measurement of the sidetone reference equivalent	445	159, 160	I bis	313, 314
3. Measurement of the intensity of microphone noise	447	—	IV	194
4. Verification from the central exchange of the efficiency of subscribers' installations in service	448	—	IV	194
(*a*) Human voice and ear testing	448	—	IV	194
(*a* 1) Rapid test by conversation	448	—	IV	195
(*a* 2) Complete telephonometric test	451	—	IV	199
(*a* 3) Measurement at the central exchange of the voltage produced by the voice currents coming from the subscriber's instrument	453	—	IV	201
(*b*) Electrical testing methods	455	—	IV	208
(*b* 1) Use of a complex electric current (rhythmic oscillator) in place of the subscriber's voice	456	—	IV	208
(*b* 2) Use of an acoustic source of complex sound (klaxon) in place of the subscriber's voice	457	—	IV	210
(*b* 3) Measurement from the exchange of the D.C. resistance of the microphone of a subscriber's set in operation ...	458	—	IV	210
C. Measurement of articulation				
(*a*) Logatoms to be used	459	161	I bis	320

	English Page.		French	
	1934	1936	Vol.	Page.
(*b*) Method of pronouncing logatoms, use of test phrases, control of volume	—	162	I bis	321
(*c*) Recording logatoms, correcting results, rest periods	—	162	I bis	322
(*d*) Method of distributing the tests, number of logatoms received per test point	—	162	I bis	323
(*e*) Various methods of making articulation tests	—	162	I bis	323
(*f*) Selection of operators for testing crews, number of operators per crew, training of operators	—	163	I bis	324
(*g*) Calibration of testing crews—Transmission system used for such calibration. Experimental practice coefficient	—	163	I bis	324
Appendix A. Establishing a collection of logatoms	461	—	I bis	326
Table of consonants (or consonances) and vowels used as the basis of logatoms in Esperanto for international articulation tests ...	462	—	I bis	327
Examples of lists of logatoms for international articulation tests ...	462	—	I bis	328
Appendix B.1. Calculation of the ideal logatom articulation of logatoms and the ideal sound articulation	463	—	I bis	329
Appendix B.2. Calibration of articulation testing crews	467	—	I bis	335
Appendix C. Another method of correcting the results or articulation measurements to allow for the crew factor of the operating team making the measurements	469	—	I bis	339
D. Measurement of effective transmission equivalent and reductions in the quality of transmission	470	—	IV	231
1. Direct measurement of effective transmission equivalent ...	470	—	IV	231
2. Measurement of transmission impairment due to line noise or to distortion	472	—	IV	233
(*a*) Method based on articulation tests	472	—	IV	234
(*b*) Method based on the observation of the repetition rate ...	472	—	IV	234
(*c*) Method based on judgment	473	—	IV	234
E. Measurement of the acoustic intensity of room noise ...	474	—	IV	236
1. Subjective measurement	474	—	IV	236
(*a*) Subjective measurement of Barkhausen	474	—	IV	236
(*b*) Subjective measurement, by the masking method ...	474	—	IV	237
2. Objective measurement	475	—	IV	238
(*a*) Method of the American sound meter	475	—	IV	238
(*b*) Method of the Siemens and Halske sound meter ...	476	—	IV	239
12. MEASURING APPARATUS				
Section I. Measuring apparatus for use at low frequencies	477	—	IV	241
1. Instruments used for the testing and measuring of insulation	477	—	IV	241
2. Instruments for the testing and measuring of resistance ...	477	—	IV	242
3. Level measuring sets	478	—	IV	243
(*a*) Generator used in conjunction with the level measuring set	478	—	IV	243
(*b*) Level measuring sets	479	—	IV	244
(*c*) Automatic level recorders	480	—	IV	246
4. Gain measuring sets	481	—	IV	248
(*a*) Generators for gain measuring sets	481	—	IV	248
(*b*) Gain measuring sets	481	—	IV	248
5. Instruments for measuring the impedance of circuits	481	—	IV	249
(*a*) Generators for these instruments	481	—	IV	249
(*b*) Impedance measuring apparatus	482	—	IV	249
(*c*) Accuracy of impedance measurement	482	—	IV	249
6. Crosstalk measuring sets	482	—	IV	250
(*a*) Generators for crosstalk measuring sets	482	—	IV	250
(*b*) Crosstalk measuring sets	482	—	IV	250
7. Apparatus for valve rejection tests	483	—	IV	251
(*a*) Method of testing	483	—	IV	251
(*b*) Applied voltage	483	—	IV	251
8. Installations permitting of checking the battery voltages and currents	483	—	IV	251
(*a*) For installations in service	483	—	IV	251
(*b*) Accuracy of current and voltage measurements	483	—	IV	251
General note on conditions which must be fulfilled by all testing instruments for use on international circuits ...	483	—	IV	252
(*a*) Influence of measuring current supplies on the batteries	483	—	IV	252
(*b*) Influence of battery noise on measuring apparatus ...	483	—	IV	252
(*c*) Mutual disturbance between measuring apparatus ...	483	—	IV	252
9. Psophometers	484	—	IV	252
A. Specification covering the principle and the method of use of psophometers used on commercial telephone circuits	484	—	IV	252
(I) Specification covering the principle	484	—	IV	252
(*a*) Weighting curve	484	—	IV	252

	English Page		French	
	1934	1936	Vol.	Page.
Table 1. Weighting factors	484	—	IV	253
Table 2. Tolerances	485	—	IV	256
(*b*) Measuring instrument	486	—	IV	256
(*c*) Input impedance	486	—	IV	256
(*d*) Sensitivity	486	—	IV	256
(*e*) Calibration	486	—	IV	257
(*f*) Special constructional conditions	486	—	IV	257
(II) Method of use	486	—	IV	257
B. Psophometer used on circuit for radio broadcast relays ...	487	—	IV	258
Table 3. Specification for the curve of the filter used in the psophometer for tests on a telephone circuit used for relaying broadcast transmission	487	—	IV	258
10. Apparatus for measuring the unbalance to earth of telephone lines	488	—	IV	260
(*a*) Method of comparison by means of an artificial line ...	488	—	IV	260
(*b*) Method of measurement by means of a potentiometer of low resistance	488	—	IV	261
(*c*) Method of measurement by means of a potentiometer of high resistance	489	—	IV	262
11. Volume indicators	490	—	I bis	342
(*a*) Volume indicator capable of measuring the electrical speech power in a telephone circuit (metallic or radio) during a continuous conversation	490	—	I bis	342
(*b*) Impulse meter giving the average or maximum impulses during a conversation, or the maximum impulses during a radio transmission	491	164	I bis	344
(*c*) Peak indicators	491	—	I bis	345
(*d*) Comparison of a volume indicator with the volume indicator used by the SFERT laboratory in telephonometric measurements	491	—	I bis	345
Note.—Results of volume measurements on international telephone circuits carried out from the toll switchboard and results of comparison tests between the volume indicator of the SFERT and some impulse meters	492	—	IV	267
(*a*) Measurements made at the toll switchboard	492	—	IV	267
(*b*) Comparative tests of volume indicators	493	—	IV	270
Artificial voice and ear for telephonometric measurements ...	498	—	I bis	346
(*a*) Artificial voice. Guiding principles in studying apparatus intended to replace the human voice in telephonometric tests or in articulation tests	—	164	I bis	346
Appendix 1. Artificial mouth by Messrs. Siemens & Halske used by the German Administration	—	166	I bis	350
Appendix 2. Description of the artificial mouth used by the Bell System, U.S.A.	—	167	I bis	353
Appendix 3. Artificial voice used by the British Post Office for routine maintenance tests at the subscriber's station	—	173	I bis	368
(*b*) Artificial ear. Guiding principles in studying apparatus intended to replace the human ear in telephonometric tests	499	—	IV	295
Sound meters. Apparatus for the objective measurement of room noise	—	181	I bis	384
Appendix I. Essential characteristics of the apparatus for the objective measurement of room noise used by the German Administration	—	182	I bis	386
Appendix II. Essential characteristics of the apparatus for the objective measurement of room noise used by the A.T. & T. Co. (conforming to the specification proposed by the Technical Committee on Noise Meters and Noise Levels of the American Standard Association)	—	183	I bis	387
Annexe 1 to Appendix II, Operating characteristics of sound meters at various frequencies	—	184	I bis	391
Annexe 2 to Appendix II. Tests concerning the summation of powers	—	186	I bis	394
Annexe 3 to Appendix II. Comparison of the operating characteristics (at various frequencies) of individual sound meters with the nominal characteristics	—	187	I bis	396
Appendix III. Bibliography for sound meters	—	189	I bis	398
I. German	—	189	I bis	398
II. American	—	190	I bis	400
III. British	—	190	I bis	400
IV. French	—	190	I bis	401
V. Swedish	—	190	I bis	401

	English Page.		French	
	1934	1936	Vol.	Page.
Apparatus for the subjective measurement of noise used by the British Post Office	504	—	IV	303
Section II. High frequency measuring apparatus	507	—	IV	309
1. Generator of high frequency measuring current	507	—	IV	309
2. Heterodyne receiver-detector	507	—	IV	310
3. Level measuring set for high frequencies	508	—	IV	310
4. Transmission measuring set for high frequencies	508	—	IV	310
5. Wheatstone bridge or differential transformer for the measurement of impedance at high frequencies	508	—	IV	311
6. Measuring apparatus for high frequency disturbing noises	508	—	IV	311
13. MAINTENANCE AND SUPERVISION OF LINES AND INSTALLATIONS				
Section I. Maintenance of circuits used for commercial telephony	509	—	I bis	403
Maintenance of good transmission	509	—	I bis	403
Non-utilisation of circuits, statistics	511	—	I bis	406
Programme of periodical maintenance	511	—	I bis	406
Instructions for the setting up and maintenance of international circuits	512	—	I bis	408
Chapter I. Setting up international circuits	514	—	I bis	411
Section A. Preliminary exchange of information	514	190	I bis	411
Section B. Arrangements, tests and preliminary measurements...	514	190	I bis	412
Section C. Final measurements and tests on complete circuits ...	516	191	I bis	414
Chapter II. Final documents and maintenance	516	—	I bis	415
Section A. Forwarding of final documents	516	191	I bis	415
Section B. Organisation of periodical tests and maintenance measurements	517	191	I bis	416
Section C. Fault localisation	523	—	I bis	428
Note concerning maintenance of circuits for voice frequency telegraphy	524	192	I bis	430
Note concerning the maintenance of circuits used for super-audio telegraphy	—	192	I bis	430
Appendix I. Assignment chart of the common frontier section	525	—	I bis	432
Appendix II. Brief specification for an international circuit ...	526	—	I bis	433
Appendix III and IIIa. Level diagrams of an international circuit	527	192	I bis	434
Appendix IV. Programme of periodic tests	529	192	I bis	438
Appendix V. Statistics of non-utilisation of circuits ...	530	—	I bis	439
Section II. Maintenance of circuits used for radio broadcasting	531	192	I bis	440
Programme of periodic maintenance of special international circuits for radio broadcasting	531	192	I bis	440
Technical responsibilities during radio broadcasts	532	—	I bis	442
Instructions for setting up a broadcast circuit transmission and for subsequently re-establishing the circuit for its normal working conditions	533	192	I bis	443
D. GENERAL ORGANISATION OF THE C.C.I.F.				
PART 1. REGULATIONS AND RECOMMENDATIONS CONCERNING THE ORGANISATION OF THE COMITÉ CONSULTATIF INTERNATIONAL TÉLÉPHONIQUE				
A. Extracts from the Telephone Regulations annexed to the International Telecommunication Convention Madrid, 1932	541	—	I bis	523
Article 37 of the Telephone Regulations	541	—	I bis	523
Internal Regulations of the International Telephone Consultative Committee (C.C.I.F.) (Appendix to Article 37 of the Telephone Regulations)	542	—	I bis	525
B. Recommendations of the International Telephone Consultative Committee	544	—	I bis	528
Organisation and Working of the International Telephone Consultative Committee (C.C.I.F.)	544	—	I bis	528
(*a*) Plenary Meeting	544	—	I bis	528
(*b*) Secretary General	544	—	I bis	529
(*c*) The Commissions of Rapporteurs (C.R.)	545	—	I bis	529
(*d*) Financial arrangements	545	225	I bis	530
Representation on the C.C.I.F. of Operating Companies in countries where the State Telephone Administration is a member of the C.C.I.F.	546	—	V	13

	English Page.		French	
	1934	1936	Vol.	Page.
Membership of the C.C.I.F. of Operating Companies in countries where there is no State Telephone Administration	546	—	V	13
Membership of the C.C.I.F. of Colonies, Protectorates and Territories governed by Sovereignty or Mandate	546	—	V	14
Technical collaboration between the C.C.I.F. and technical organisations dealing with questions likely to have a bearing on international telephony	547	—	V	14
Collaboration between the C.C.I.F. and the Bureau of the International Telecommunication Union	547	—	V	15
Liaison committee between the various international organisations engaged on questions relating to electricity	547	—	V	15
Secretariat staff rules of the C.C.I.F.	548	—	V	16
Staff rules of the European master reference system for Telephone Transmission Laboratory	549	—	V	18
E. OPERATING AND TARIFFS				
A. **General. Recommendations Nos. 1-13** (see below) ...	551-568			
B. **Various classes of calls and facilities offered to the public, Recommendations Nos. 14-27**	572-586			
C. **Methods of operating. Recommendations Nos. 28-42** ...	587-597			
D. **Tariffs and method of applying tariffs. Recommendations Nos. 43-59**	598-614			
E. **Traffic statistics. Recommendations Nos. 60-64**	615-623			
LIST OF RECOMMENDATIONS ESSENTIAL FOR OPERATING INTERNATIONAL TELEPHONE CIRCUITS				
Recommendations Nos. 2, 3, 6, 10, 11, 14, 16-36 inclusive, 39, 40, 43, 44, 45, 47, 48, 50-59 inclusive, and 62				
INDEX OF RECOMMENDATIONS*				
A. **Recommendation No. 1.** Definitions concerning operating in international telephony	551	—	V	21
Recommendation No. 2. Decentralisation of international traffic	555	—	V	29
Recommendation No. 3. Maximum waiting time for ordinary international calls	555	—	V	30
Recommendation No. 4. Establishment of the nomenclature of the international circuits and the schematic plan of the cables	556	225	I bis	532
Recommendation No. 5. Establishment of a plan of European international circuits specially designed or arranged for music transmission	560	—	V	37
Recommendation No. 6. Extension of the international telephone service	561	—	V	39
Recommendation No. 7. Arrangement between two countries for international telephone service	562	—	V	40
Recommendation No. 8. Opening of new services—Publicity calls	565	—	V	44
Recommendation No. 9. Method of indicating to the exchanges normal and auxiliary routes	565	—	V	45
Recommendation No. 10 Emergency lines	566	226	I bis	539
Recommendation No. 11. Emergency land lines extending a radio telephone link	567	—	V	49
Recommendation No. 12. Telephone directories	568	—	V	49
Recommendation No. 13. Publication of pamphlets giving the international connections authorised, the facilities offered and the corresponding tariffs	568	—	V	51
B. **Recommendation No. 14.** Subscription calls	572	228	I bis	544
Recommendation No. 15. Agreement to be concluded between exchanges and subscribers for the exchange of fixed-time calls (now replaced by Recommendation No. 14)	572	—	V	61
Recommendation No. 16. Calls by subscription for periods of less than one month (now replaced by Recommendation No. 14)	574	—	V	61
Recommendation No. 17. Occasional calls at fixed time ...	575	—	V	61
Recommendation No. 18. Calls with avis d'appel and calls with préavis	575	231	I bis	549

* Not given in the French text.

		English Page.		French	
		1934	1936	Vol.	Page.
	Recommendation No. 19. Bourse calls	580	233	I bis	557
	Recommendation No. 20. Calls paid by the person called ...	581	233	I bis	559
	Recommendation No. 21. Requests for information ...	582	—	V	73
	Recommendation No. 22. Leasing international lines, not comprising submarine sections, for private purposes	583	234	I bis	561
	Recommendation No. 23. Conference calls	584	—	V	76
	Recommendation No. 24. Calls demanded by aeroplane pilots in cases of forced landings	584	—	V	77
	Recommendation No. 25. Modifications to demands for calls at the request of the caller	585	—	V	78
	Recommendation No. 26. Transmission of demands for calls during heavy traffic	585	—	V	79
	Recommendation No. 27. Priority of international calls over internal calls	586	—	V	80
C.	**Recommendation No. 28.** Operating international circuits ...	587	—	V	80
	Recommendation No. 29. Assignment of the serial number to the call	587	234	I bis	563
	Recommendation No. 30. Enunciation of subscribers' numbers	587	—	V	81
	Recommendation No. 31. General principles for equalising waiting times in both directions	588	—	V	82
	Recommendation No. 32. Telegraphic preparation of telephone calls	588	—	V	83
	Recommendation No. 33. Maximum duration of test calls before the establishment of communication between subscribers	592	—	V	88
	Recommendation No. 34. Advice given to the terminal exchange at the calling end that the called stations have replied	592	—	V	89
	Recommendation No. 35. Calls during which difficulties in hearing arise	592	—	V	89
	Recommendation No. 36. Operating rules for international transit traffic	593	234	I bis	564
	Recommendation No. 37. Conditions which should be fulfilled concerning the operation of inter-communication systems between international four-wire and two-wire circuits	595	—	V	93
	Recommendation No. 38. System of spelling and phrases to be used for operating international circuits	595	—	V	93
	Recommendation No. 39. Calls without préavis to a subscriber's station, the number of which has been changed or which has been temporarily referred to "absent subscriber's service"	596	—	V	94
	Recommendation No. 40. Checking the number of minutes of conversation between terminal exchanges on international lines	596	—	V	95
	Recommendation No. 41. Instruction of the personnel of the telephone exchanges	597	—	V	96
	Recommendation No. 42. Service instructions for the use of long-distance operators	597	—	V	96
D.	**Recommendation No. 43.** International telephone charges ...	598	234	I bis	566
	Recommendation No. 44. Rates for conference calls	600	—	V	101
	Recommendation No. 45. Rates for subscription calls ...	600	—	V	101
	Recommendation No. 46. Rates applicable to calls originating from, or to be completed at, a public call box	601	—	V	102
	Recommendation No. 47. Rates applicable to press calls ...	601	—	V	102
	Recommendation No. 48. Calls made to a wrong number ...	601	—	V	103
	Recommendation No. 49. Minimum traffic to be guaranteed to transit countries	602	—	V	104
	Recommendation No. 50. Radio broadcast transmissions ...	603	235	I bis	570
	Recommendation No. 51. International calls using a radio telephone circuit	610	—	V	116
	Recommendation No. 52. Picture transmission between correspondents over general service circuits (conditions relating to acceptance and tariffs)	610	—	V	116
	Recommendation No. 53. No reply from the calling or called subscriber	611	—	V	119
	Recommendation No. 54. Application of report charges in connection with radio telephone circuits	612	—	V	120
	Recommendation No. 55. Standardisation of the hours of light traffic for the application of tariffs	613	—	V	120
	Recommendation No. 56. Tolerance and arrangements for registering the duration of calls	613	—	V	121

	English Page.		French	
	1934	1936	Vol.	Page.
Recommendation No. 57. Recording the chargeable duration of calls	613	—	V	121
Recommendation No. 58. Defaulting subscribers	614	—	V	122
Recommendation No. 59. Publicity expense	614	—	V	123
E **Recommendation No. 60.** International traffic statistics ...	615	—	V	124
Recommendation No. 61. Publication of general telephone statistics by the International Telecommunication Union ...	617	—	V	127
Recommendation No. 62. Supervision of international telephone traffic	620	—	V	131
Recommendation No. 63. Formula for determining the necessary number of circuits to handle a given traffic during various hours of the day	623	—	V	135
Recommendation No. 64. Forecast of international traffic. Lists of circuits to be established	623	237	I bis	580

APPENDIX

FOR purposes of reference pending the next Plenary Meeting and the subsequent new issue of "Proceedings," the following Appendix has been included giving the major recommendations regarding transmission which were made by the 3rd, 4th and 5th C.R.'s at their meeting in Oslo, June 20th to July 2nd, 1938.

The recommendations summarized under sections A to D, inclusive, in accordance with the decision of the XIIth Plenary Meeting at Cairo, will be submitted to all Administrations and Operating Companies adherent to the C.C.I.F. for a postal vote and, if passed, will be considered as being provisionally in force as from January 1st, 1939.

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

SUMMARY OF PRINCIPAL RECOMMENDATIONS MADE BY THE 3rd, 4th AND 5th C.R.'s AT THEIR MEETING IN OSLO, JUNE 20th TO JULY 2nd, 1938.

A. GENERAL EUROPEAN TOLL SWITCHING PLAN.

The C.C.I.F., in consideration of the fact :

That Article 3 entitled " Constitution and Utilisation of Telephone Networks " of the Telephone Regulations of Cairo, 1938 (annexed to the International Tele-communications Convention of Madrid, 1932) stipulates that the interested Administrations and private Operating Companies shall determine the normal routing of calls by giving first importance to the quality of transmission ; and

That inter-continental service is still only slightly developed and inter-continental circuits are not only of a special type, but are subject to continued improvement,

Proposes :—

(1) That it is desirable to establish guiding principles for the establishment of a General European Switching Plan for international connections, but that for the moment the study should be limited to the part of this programme which concerns European continental communications or the European section of the connection with other countries ;

(2) That it is desirable to establish

(*a*) a classification of the switching offices in Europe under the headings of toll offices, national transit centres, international switching centres and continental switching centres ;

(*b*) a " List of International Telephone Routes used in Europe (normal routing, auxiliary routing and emergency routing)," to be kept up to date at regular intervals.

(3) That while waiting for the preparation of the classification mentioned above the European Administrations and private Operating Companies follow the " Guiding Principles for the Establishment of a General European Toll Plan " and apply the essential recommendations of the C.C.I.F. concerning transmission and maintenance summarised in these guiding principles ;

(4) That with regard to the organisation of international telephone routes in Europe, the Administrations and private Operating Companies attempt (*a*) to reduce as far as possible the number of switching points in an international connection and to make arrangements that any toll centre can arrive at the international switching point by passing through not more than one transit centre ; (*b*) to establish direct circuits of sufficient number that in an international connection there will not be more than two intermediate switching centres between the two terminal international switching centres ; (*c*) to keep their traffic and exploitation personnel advised by tables giving the routing which should be followed for a given connection, such routing being determined both from the technical standpoint and the standpoint of traffic, and covering both the international and national lines to be used ; (*d*) to organise the central offices in such a manner that the traffic personnel cannot make any changes in the technical conditions of the overall connection.

GUIDING PRINCIPLES FOR THE ESTABLISHMENT OF A GENERAL EUROPEAN SWITCHING PLAN.

Typical International Connection.

In the immediate future attempts should be made to re-organize the national and

international networks in order to conform to the typical international connection shown in Figure 1.

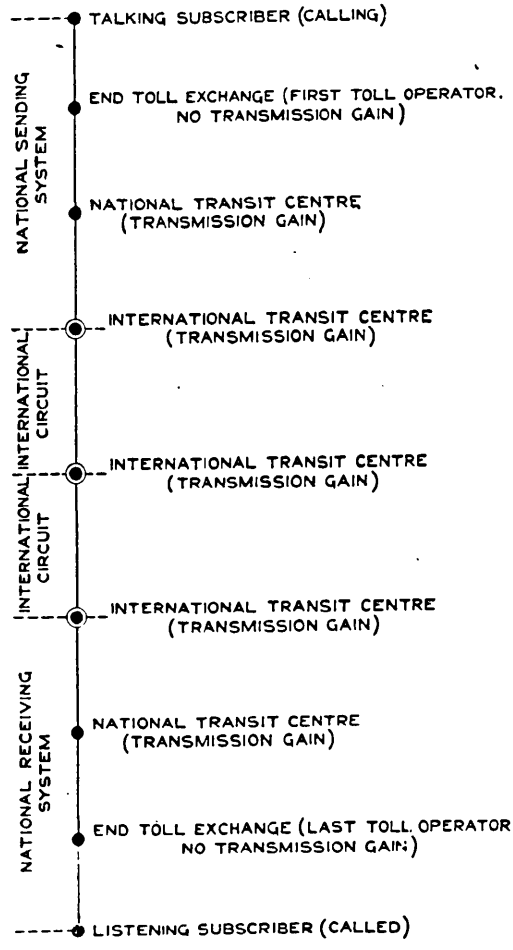


FIG. 1

Conditions which should be fulfilled by telephone lines and equipment in order to provide a satisfactory transmission standard.

International telephone circuits (together with national circuits and equipment, local lines and subscribers' sets utilized for international service), should be set up and maintained in such a manner that the essential recommendations of the C.C.I.F. regarding transmission will always be observed in the European international telephone service.

These essential recommendations are as follows :—

I. Reference Equivalent.

Limits in practice for the reference equivalent of the over-all connection between two subscribers, the reference equivalent of the national sending system, and the reference equivalent of the national receiving system.

In an international telephone connection between two subscribers in the same continent the total over-all reference equivalent should not be greater than 4.6 nepers or 40 db.

The reference equivalent in the transit condition of the national sending system should not be greater than 2.35 nepers or 20.5 db.

The reference equivalent in the transit condition of the national receiving system should not be greater than 1.85 neper or 16 db.

The above limits result from the following allocation of losses : $4.6 = 2.35 + 0.4 + 1.85$ in which the value 0.4 neper is for the international portion of the connection, and takes into account the possible variation of the actual equivalent of the international circuits from their nominal value of 0 neper and also the possible variations with time of the international circuits which may make up the international portion of the connection.

Limits in practice of the reference equivalent of an international circuit.

1. Equivalent in the Terminal Condition.

The nominal equivalent of an international circuit in its terminal condition, measured at 800 cycles from the switchboard jacks, and including the line transformers shall not be greater than 1.0 neper or 8.7 db for a two-wire circuit, and 0.8 neper or 6.7 db for a four-wire circuit.

2. Equivalent in the Transit Condition.

The nominal equivalent of an international circuit in the transit condition between the " conventional points of origin " shall be 0 neper, with a possible maximum value of 0.1 neper or 0.87 db.

II. Frequency Distortion.

Frequency band effectively transmitted and frequency distortion for two-wire circuits, four-wire circuits and circuits obtained by carrier systems which provide one channel in addition to the regular voice-frequency channel.

For voice-frequency circuits constructed in the future the frequency distortion shall be such that the band of frequencies effectively transmitted shall be at least 300 cycles to 2 600 cycles. The limits for the allowable variation of the equivalent with frequency are given in Fig. 2 below and Fig. 3 on the next page.

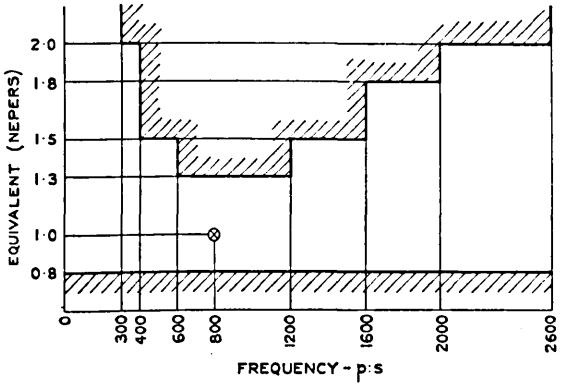


FIG. 2

Limits of the equivalent to an international two-wire circuit in terminal service.

Note.—The curve of the equivalent in terms of frequency should lie between the two shaded areas.

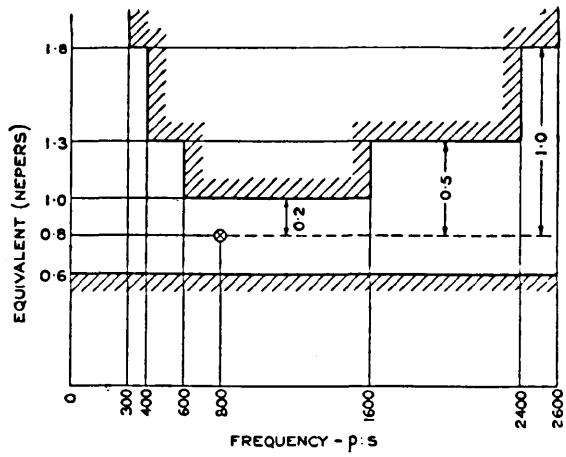


FIG. 3

Limits of the equivalent of an international four-wire circuit in terminal service.
Note.—The curve of the equivalent in terms of frequency should lie between the two shaded areas.

Band of frequencies effectively transmitted and frequency distortion for circuits obtained by carrier systems providing two, three or four channels in addition to the regular voice-frequency channel.

Provisionally, circuits of this type should meet the requirements for four-wire circuits given above.

Band of frequencies effectively transmitted and frequency distortion for circuits obtained by carrier over non-loaded cables or coaxial cables.

The C.C.I.F., considering :—

That during recent years there has been a very considerable improvement in the quality of transmission of subscribers' sets

Recommends unanimously :—

That it is desirable to enlarge, in the future, the band of frequencies transmitted on long distance communications ;

that the application of the transmission of this wider band be applied progressively to all classes of lines and circuits ;

that, as a start, the band of frequencies effectively transmitted by any channel obtained in the future by carrier on non-loaded cables extend from 300 cycles to 3 400 cycles, corresponding to a spacing of carrier frequencies of 4 000 p : s.

III. Echo Effects.

It is necessary always to foresee the use of echo-suppressors on international circuits used for transit traffic. In the case of terminal circuits, echo suppressors should be provided when a calculation of echo effects shows that this is necessary.

It is recommended that terminal echo-suppressors be used in the following three cases :—

(*a*) When long-distance dialling is used in connection with the circuit.

(*b*) When it is planned to use the circuit for ultra-acoustic telegraphy.

(*c*) When carrier systems are used over the circuit.

Note on the Calculation of Echo Effects on Circuits Equipped with Echo Suppressors.

As a provisional measure, and until a curve universally accceptable is arrived at, the curve given in Fig. 4 shall be used in the calculation of echo effects on circuits equipped with echo suppressors.

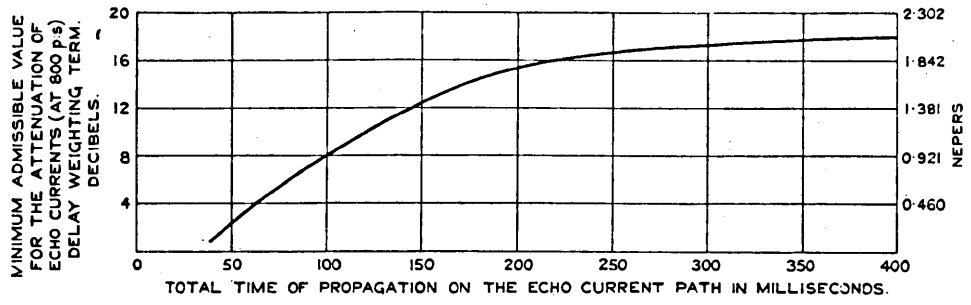


FIG. 4

Curve showing the minimum admissible value for the attenuation of echo current for circuits equipped with echo suppressors (sensitivity referred to zero relative level: 30 decibels).

Note.—The above curve is adopted *provisionally* until universal agreement is obtained for such a curve.

IV. Stability.

The stability of any chain of international circuits between the two terminal long-distance exchanges when the ends of such a chain of circuits are open-circuited should, provisionally, not be less than 0.2 neper or 1.74 db.

V. Propagation Time.

The propagation time for an over-all continental connection between two subscribers shall, provisionally, not be greater than 250 milliseconds.

To meet the above limit the propagation time of the national transmitting system and of the national receiving system shall not be greater than 50 milliseconds and the propagation time of the international portion of the overall connection shall, provisionally, not be greater than 150 milliseconds.

The above are maximum values. For purposes of calculation in the study of the General European Switching Plan a value of 100 milliseconds will be assumed, rather than 150 milliseconds, for the international portion of the connection.

VI. Phase Distortion.

The phase distortion on international circuits should be such that the difference in propagation time for the total international portion of a built-in connection does not exceed the following values :—

(1) Between the propagation time at 800 cycles and the propagation time at the minimum frequency effectively transmitted... ... ... 10 milliseconds.

(2) Between the propagation time at 800 cycles and the propagation time at the maximum frequency effectively transmitted ... ... 5 milliseconds.

The phase distortion on the complete international connection betweeen the terminals of the subscribers' sets at either end should be such that the difference in propagation times does not exceed the following values :—

(1) Between the propagation time at 800 cycles and the propagation time at the minimum frequency effectively transmitted... ... ... 30 milliseconds.

(2) Between the propagation time at 800 cycles and the propagation time at the maximum frequency effectively transmitted ... ... 15 milliseconds.

In general the phase distortion of international circuits and of national circuits utilized in international connections (including the associated equipment) should not exceed the following values :—

	Minimum frequency effectively transmitted.	Maximum frequency effectively transmitted.
1. In the case of a Continental connection :—		
(a) On the international portion of the connection	10 milliseconds	5 milliseconds
(b) On each of the national portions of the connection	20 milliseconds	10 milliseconds
(c) On the over-all connection	50 milliseconds	25 milliseconds
2. In the case of an Intercontinental connection :		
(a) Between the subscriber and the point of origin of the intercontinental circuit	30 milliseconds	15 milliseconds

VII. Noise and Crosstalk.

Noise. The total noise on an international circuit should be sufficiently small that the psophometric E.M.F. measured at the end of the line conductors shall be less than 5 millivolts in the case of open-wire lines not equipped with repeaters, and less than 2 millivolts in the case of cable circuits. If an open-wire line is equipped with terminal repeaters the noise on such an open-wire line shall be such that when amplified by the terminal repeater the psophometric E.M.F. does not exceed 5 millivolts.

Crosstalk. The far-end and the near-end crosstalk attenuation between two international circuits in the same cable in the terminal condition (equivalent adjusted to 0.8 neper for a four-wire circuit, and to 1.0 neper for a two-wire circuit) shall not be less than 7.5 nepers or 65.1 db for 90 per cent. of the combinations ; and 6.8 nepers or 59 db for 100 per cent. of the combinations.

VIII. Non-linear Distortion.

No specific limits are established for this factor.

IX. Interconnection and Impedance of International Circuits.

The interconnection of two international four-wire circuits should be made in such a manner that the equivalent and the stability of the combined over-all circuit is practically the same as if it were a single four-wire circuit between the two far-end terminating points.

The impedance of an international circuit (as seen from the toll board, and measured or calculated at 800 cycles) should, in principle, be between the limits of 600 ohms and 950 ohms ; however, an attempt should be made in the future to keep the value of this impedance as near as possible to 600 ohms.

B. TRANSMISSION OF SIGNALS OVER INTERNATIONAL CIRCUITS FOR AUTOMATIC OR SEMI-AUTOMATIC OPERATION.

The International Telephone Consultative Committee, considering :—

That it is desirable in future to introduce automatic selection over long distance circuits by

operators, not only within one country but between various countries (so that ultimately it would be possible for an operator to reach automatically any subscriber).

Unanimously recommends :—

1. That the frequencies to be used in Europe for transmission of automatic selection signals over international circuits should be fixed at 600 and 750 p : s.

2. That, in order to standardise signalling in Europe for automatic or semi-automatic working, the following guiding principles should be followed, assuming the general case of the international circuit equipped with an intermediate echo suppressor.

Guiding principles for the transmission of signals over international circuits for automatic or semi-automatic traffic.

Suffix Signals.

It is recommended that the principal signals should be distinguished from the auxiliary signals.

By principal and auxiliary signals the following are meant :—

Principal Signals :—

(1) Seizing signal (Signal de prise, Belegen).

(2) Impulsing signal (Signal de numérotation, Wählen).

(3) Answer signal (Signal de réponse du demandé, Gesprächsbeginn).

(4) Clearback signal (Signal de raccrochage du demandé, Beobachten).

(5) Release signal (Signal de libération, Auslösen).

Auxiliary Signals (as an example) :—

(1) Forward transfer signal (Signal d'intervention d'une operatrice côté demandé, Umlegen).

(2) Trunk offering signal (Signal d'offre, Vorwärts-anbieten).

(3) Breakdown signal (Signal de coupure, Ferntrennen).

(4) Ring forward signal (Signal d'appel du demandé, Rufen).

Constitution of the Signals :—

(1) Seizing signal consists of one short impulse at a frequency of 750 p : s.

(2) Impulsing signal consists of impulses of 750 p : s.

(3) Answer signal consists of a prefix signal followed by a short signal of 750 p : s (see the note under " release signal " below).

(4) Clearback signal consists of one signal element made up of a prefix portion and a suffix portion at a frequency of 600 p : s. The complete signal consists of a repetition of this signal element. The silent pauses between the signal elements must be longer than 550 milliseconds. The signal continues until the release signal or the called person hangs up.

(5) Release signal.

Two cases have to be considered :—

(*a*) Under certain circumstances the release signal is transmitted forward, that is from the caller toward the called person. This release signal then consists of a prefix signal followed by a long signal at 600 p : s.

(*b*) In other circumstances a signal is first transmitted forward which consists of a prefix signal followed by a short signal at 600 p : s. This signal orders the emission of the release signal which is sent backwards, that is a prefix signal followed by a long signal, at 600 p : s (see the remark above).

IMPORTANT NOTE :—

In all cases arrangements must be made to ensure that these signals are effectively received.

Auxiliary Signals.

The guiding principles for these signals will be drawn up later.

Duration of Signals.

Short signals are those of between 60 and 100 milliseconds.

Long signals are from 300 to 400 milliseconds in duration,

Two-frequency prefix signals are between 250 and 350 milliseconds in duration.

Single frequency prefix signals. The duration of these will be fixed later.

Pause between prefix signal and suffix signal must be between 30 and 50 milliseconds in duration.

Repetition of signals. When signals are repeated the silent interval between two signals must be at least of 550 milliseconds duration.

Guiding principles for the general arrangements to be made to prevent interference on international communications by the voice frequency signalling systems used in national networks.

At present it is difficult to prescribe any general arrangement for preventing interference in national networks which use voice frequency signalling other than 600 or 750 p : s when such networks are connected by an international circuit.

For networks, however, which use the frequencies of 600 and 750 p : s selected by the C.C.I.F., and which are connected by an international circuit, the following recommendations can prevent interference within these national networks. It is recommended to insert in the circuits devices which prevent the passage to the international circuit of any signal of a greater duration than :—

400 milliseconds for a single frequency signal (600 or 750 p : s).

150 milliseconds for a two-frequency signal (600 and 750 p : s).

C. GENERAL RULES CONCERNING THE CONSTITUTION OF TRANSMISSION SYSTEMS.

SECTION I. ORDINARY TELEPHONY.

General conditions to be satisfied by international circuits used for ordinary telephony.

The International Telephone Consultative Committee

Unanimously recommends :—

(1) That, in cables to be laid in the future, 4-wire circuits will be used for international circuits

of a total length between the extreme toll terminal exchanges of over 300 km ; such circuits shall effectively transmit a band of frequencies of from 300 to 2 600 p : s (a frequency is effectively transmitted if the equivalent for this frequency does not differ by more than 1.0 neper or 8.7 decibels from the equivalent at 800 p : s).

(2) That, to handle terminal traffic between international exchanges, between which the air-line distance does not exceed 300 km, two-wire circuits may be used ; but in cables to be laid in the future these circuits must effectively transmit a band of frequencies from at least 300 to 2 600 p : s (with the limits of attenuation distortion conforming to diagram No. 1 of the " General European Switching Plan ").

Relative Levels.

It is convenient to consider as the origin for the determination of relative levels, the end of the circuit at the sending exchange (toll test board at this exchange). A correction must be made to allow for the difference of impedance of the line at the two points where the measurement is carried out. If, at the point in question, the value of the power, voltage or current as the case may be, is greater than the value measured at the point of origin, the relative level at this point is positive (+ n) ; if it is less, the relative level is negative (– n).

In four-wire circuits, seeing that the equivalent may vary with the frequency within the limits specified in Fig. 3 of the " European General Switching Plan," it is convenient to admit for this type of circuit and for the relative power levels at the output of the frontier repeaters toward the frontier side, the limits given in Fig. 5, below the nominal relative level of power (at 800 p : s) having the appropriate value of + 0.5 neper or + 4.3 decibels.

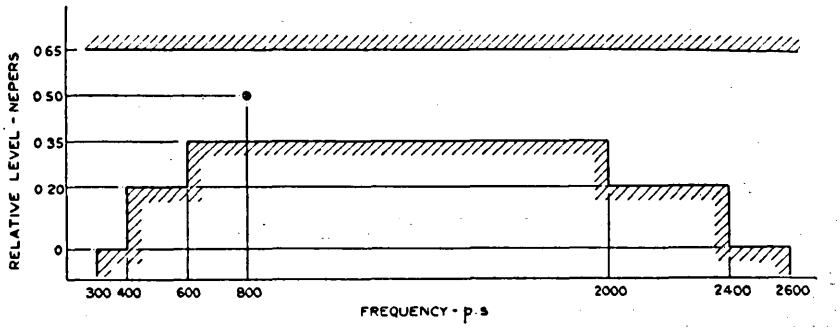


FIG. 5.

Limits of relative power levels at the output of a frontier repeater on an international four-wire circuit.

Note.—No point representative of a value of relative power level should fall within the shaded area.

It does not appear necessary to fix special tolerances for the variation as a function of the frequency of the level measured at the output of a frontier repeater since this figure is easily calculated from the tolerances admitted for the relative power level.

At any point on a four-wire circuit, and for any frequency within the band of frequencies effectively transmitted, the relative power level should neither be greater than 1.1 neper or 9.5 decibels, nor less than –3.0 nepers or –2.6 decibels. These maximum and minimum values are valid in the case where vacuum tubes are used developing a maximum power of about 50 or 60 milliwatts and for cables where a psophometric E.M.F. of 5 millivolts at the end of the circuit is admitted.

SECTION II. CARRIER CURRENT TELEPHONY.

General characteristics of multiple carrier telephone systems on non-loaded international circuits.

Frequency band effectively transmitted by each telephone channel.

The C.C.I.F., considering :—

That during recent years there has been a very considerable improvement in the quality of transmission of subscribers' sets

Recommends unanimously :—

That it is desirable to enlarge, in the future, the band of frequencies transmitted on long distance communications ;

that the application of the transmission of this wider band be applied progressively to all classes of lines and circuits ;

that, as a start, the band of frequencies effectively transmitted by any channel obtained in the future by carrier on non-loaded cables extend from 300 cycles to 3 400 cycles, corresponding to a spacing of carrier frequencies of 4 000 p : s.

Total band width used. Number of channels per group.

The total band-width used is from 12 000 p : s to 60 000 p : s. In this band a group of 12 adjacent channels is utilised.

Carrier frequencies and side-band transmitted.

On international circuits the side-band transmitted over the line is the upper side-band corresponding to the following virtual carrier frequencies :—

12, 16, 20 ... ... 56 kc : s.

The virtual carrier frequency (Fréquence porteuse virtuelle Nullfrequenz), is the frequency which would be transmitted over the line if zero frequency were applied at the low frequency input of the channel considered.

Stability of carrier frequencies.

Any virtual carrier frequency must be stable within $\pm$ 2 p : s.

Variation of the equivalent of a complete circuit as a function of time.

These circuits should satisfy the conditions laid down for four-wire circuits in the " General European Switching Plan."

Relative Levels.

(*a*) **Relative power levels at the output of the intermediate repeaters on each channel of a 12-channel system.**

For information the present practice in Germany and Great Britain is as follows :—

	Output Level.	Input level of the channel with the highest carrier frequency.
Germany	... + 0 neper	– 6.0 nepers
Great Britain	... + 5 decibels	– 55 decibels

(*b*) **Relative levels at the input of the modulator and the output of the demodulator.**

For information the relative power level at the voice frequency terminals of the modulator can, according to the specifications in use in the U.S.A., be taken as being equal to –13 decibels and the

relative level of power at the voice frequency terminals at the output of the demodulator may be taken as being equal to + 4 decibels, the corresponding relative level at the toll switchboard being equal to zero.

If there are filters associated with the modulator or demodulator they are considered as included in the modulator or demodulator.

Crosstalk.

1. Linear Crosstalk.

(*a*) **For a repeater section terminated by its characteristic impedance.**

The crosstalk difference (écart diaphonique) between circuits in the same direction and between circuits in opposite directions should be equal to at least 8.0 nepers (69.5 decibels).

A future recommendation will fix the partition to be made between the reduction of near end crosstalk and the reduction of the reflection effects of the repeaters.

(*b*) **For a complete circuit.**

(See the " General European Switching Plan.")

2. Non-linear Crosstalk.

It is recommended that the total noise measured at the end of one channel of a carrier system on non-loaded cable, inclusive of the noise due to non-linear crosstalk, must not exceed a psophometric E.M.F. of 2 millivolts under service conditions. (See the paragraph headed " noise " of the " General European Switching Plan ").

Non-linear distortion of repeaters.

In the case of intermediate repeaters for 12-channel systems, the attenuation of harmonic distortion is measured under the following conditions :—The power at the output of the repeater should correspond to the application of a power of 1 milliwatt at the origin of a single telephone channel ; the frequency for the test should be 15 000 p : s. The measurement should be made including the transformers associated with the repeater, the power supply of the repeater tubes having normal value.

The attenuation of harmonic distortion thus measured must be at least equal to 8.0 nepers or 69.5 decibels.

D. SPECIFICATION A. II—ESSENTIAL CLAUSES FOR A TYPICAL SPECIFICATION OF GENERAL APPLICATION TO LOADING COILS FOR INTERNATIONAL TELEPHONE CABLES.

Effective Resistance.

The effective resistance of loading coils for physical and phantom circuits measured on one loading unit with a current of 1 milliampere must not exceed the following :—

(1) For telephone circuits for voice frequency use :—
175 ohms per henry at 2 400 p : s.

(2) For circuits providing one telephone carrier channel in addition to the ordinary low frequency channel :—
400 ohms per henry at 5 700 p : s.

(3) For circuits providing three telephone carrier channels in addition to the ordinary low frequency telephone channel :—
1 200 ohms per henry at 14 700 p : s.

(4) For special circuits for broadcasting :—

300 ohms per henry at 6 400 p : s.

Note.—In the case of circuits providing 3 carrier telephone channels in addition to the ordinary low frequency telephone channel, the figure of 1 200 ohms is fixed provisionally ; in future an endeavour should be made to lessen this figure.

The additional resistance due to the hysteresis h measured at 800 p : s and expressed in ohms per milliampere and per henry must not exceed the following :—

1. For two- or four-wire circuits used solely for voice frequency transmission :—
   $h = 12 \sqrt{L}$ ohms/mA × H.
2. For circuits operated with one additional carrier telephone channel :—
   $h = 6 \sqrt{L}$ ohms/mA × H.
3. For circuits operated with three additional carrier telephone channels :—
   $h = 3.3 \sqrt{L}$ ohms/mA × H.
4. For special broadcast circuits :—
   $h = 6 \sqrt{L}$ ohms/mA × H.

In the above L is the inductance of the coil in henrys.

E. NON-LINEAR DISTORTION PERMISSIBLE ON CIRCUITS FOR BROADCAST TRANSMISSIONS.

The 3rd, 4th and 5th C.R. propose to the XIIIth Plenary Meeting of the C.C.I.F. at Lisbon, 1940:—

(1) To modify the actual recommendation concerning the non-linear distortion of a repeater used for relaying broadcast transmissions (White Book I bis 225, English Edition, 1934, page 266), as follows :—

" Non-Linear Distortion "

(*a*) **Harmonic Distortion.** The coefficient of harmonic distortion should be equal to or less than 1% within the frequency band 100–8 000 p : s ; it is only for frequencies between 100–30 p : s that the coefficient can be increased to 4%.

(2) To modify the actual recommendation concerning the non-linear distortion of a circuit for broadcast transmissions (White Book I bis, page 192, English Edition, 1934, page 247), as follows :—

" Non-Linear Distortion "

(*a*) **Harmonic Distortion.** For all voltages up to the maximum peak voltage and for a basic circuit of 1 000 km, the coefficient of harmonic distortion should be less than a value provisionally fixed at 6% within the frequency band 100–8 000 p : s, and less than 15% within the band 30–100 p : s.

In future an effort should be made to fix a maximum for the harmonic distortion, under the above conditions, of 4% within the frequency range 100–8 000 p : s, and 10% within the frequency range 30–100 p : s.

(3) To delete, in the actual recommendation concerning repeaters for broadcast circuits, the phrase referring to the gain as a function of the output voltage of such a repeater (White Book I bis at the bottom of page 223, last phrase, English Edition, 1934, page 266—4th line), and to insert after the text entitled " Non-Linear Distortion—Harmonic Distortion " the following new paragraph :—

" Variation in the gain as a function of the output voltage."

The gain should not vary by more than 0.5 neper within the band 30–600 p : s, and more than 0.01 neper for higher frequencies, when the output voltage varies from 0.775 volt to 4 volts.

(4) To insert on page 192 of White Book, Vol. I bis (English Edition, 1934, page 247) in the recommendation concerning circuits for broadcast transmissions, after the new paragraph entitled " Non-Linear Distortion : (*a*) Harmonic Distortion " (see above), the following new text :—

" (*b*) **Variation of the equivalent as a function of the voltage applied at the origin.**"

For a circuit of 1 000 km, when the output voltage of the first repeater of a circuit varies from 0.775 volt to 4 volts, the variation of the equivalent of the circuit should be less than 1.0 neper within the band 30–600 p : s, and less than 0.2 neper for higher frequencies.

F. CROSSTALK.

The 3rd C.R. propose to the XIIIth Plenary Meeting of the C.C.I.F. at Lisbon, 1940 :—

1. To change the text of the paragraph, " Crosstalk and other disturbances," on page 158 of White Book Vol. I bis (English Edition, 1936, page 114), as follows :—

" Provisionally the far-end and the near-end crosstalk attenuation between two international circuits in the same cable in the terminal condition (equivalent adjusted to 0.8 neper for a four-wire circuit, and to 1.0 neper for a two-wire circuit) shall not be less than 7.5 nepers or 65.1 db for 90 per cent. of the combinations ; and 6.8 nepers or 59 db for 100 per cent. of the combinations."

G. FREQUENCY BAND EFFECTIVELY TRANSMITTED.

The 3rd and 4th C.R. propose to the XIIIth Plenary Meeting of the C.C.I.F. at Lisbon, 1940, the adoption of the following recommendation :—

That it is desirable to enlarge, in the future, the band of frequencies transmitted on long distance communications ;

that the application of the transmission of this wider band be applied progressively to all classes of lines and circuits ;

that, as a start, the band of frequencies effectively transmitted by any channel obtained in the future by carrier on non-loaded cables extend from 300 cycles to 3 400 cycles, corresponding to a spacing of carrier frequencies of 4 000 p : s.

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

METHOD OF USING THE INDEX.

1. Reference should always be made to the index on page 351, which covers both the present volume and the 1934 English edition. The index of the 1934 English edition should not be used.

2. When the page number of the 1934 English edition only is given, it indicates that no change has been made to the original text.

Thus :—

	English Edition		French Text	
	1934	1936	Vol.	Page
Acousto-electric index	178	—	1 bis	74

3. When the page numbers of both the 1934 and 1936 editions are given the indication is that the 1934 text is modified by the 1936 text. Reference should then be made to both volumes.

Thus :

	English Edition		French Text	
	1934	1936	Vol.	Page
Call: Préavis	577	231	1 bis	553

4. When the page number of the 1936 edition only is given it indicates that the text of the 1934 edition has been replaced by that of the 1936 edition, or that the new text covers a new subject or new information not presented in the 1934 edition.

Thus :

	English Edition		French Text	
	1934	1936	Vol.	Page
Reflection Coefficient: Limits	—	145	1 bis	253
Correctors: Fading	—	113	1 bis	156

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

GENERAL INDEX

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Acoustic :				
Inertance	62	—	I	93
Pressure on the diaphragm of microphone	179	—	I bis	76
Resistance	62	—	I	93
Shock. Protection of Operators	—	42	II bis	32
Stiffness	63	—	I	93
System	66	—	I	99
Vocabulary	58	—	I	85
Acousto-electric index	178	—	I bis	74
Aircraft. Forced landing	584	—	V	77
Anti-resonance	63	—	I	94
Apparatus. Testing and Measuring. (See "Testing Apparatus.")				
Arrestors :				
Lightning	—	47	II bis	41
Articulation :				
Band	182	—	I bis	81
	463	—	I bis	329
Correction of measurement for Crew Factor	469	—	I bis	339
Definitions	181	—	I bis	81
	463	—	I bis	329
Effect on, by non-linear distortion	233	—	I bis	159
Ideal	182	—	I bis	82
	463	—	I bis	329
Logatom	62	—	I	92
	182	—	I bis	81
Measurement. General instructions	—	161	I bis	320
Calibration of testing crews	—	163	I bis	324
Logatoms to be used	459	161	I bis	320
Method of distributing the tests, number of logatoms received per test point	—	162	I bis	323
Method of pronouncing logatoms, use of test phrases and control of volume	—	162	I bis	321
Recording logatoms, correction of results, rest periods	—	162	I bis	322
Testing crews	—	163	I bis	324
Various methods of making articulation tests	—	162	I bis	323
Measurement. Low Pass Filter	465	—	I bis	333
Sound	62	—	I	92
	182	—	I bis	81
	463	—	I bis	329
Testing Crews	467	—	I bis	335
	—	163	I bis	324
Testing Crews. Specification of characteristic curves, by Dr. Collard	45	—	I	65
Testing Crews. Observations by Messrs. Siemens & Halske	46	—	I	68
Artificial Mouth and Ear	—	164	I bis	346
Artificial Mouth used by the Bell System	—	167	I bis	353
,, ,, used by German Administration	—	166	I bis	350
,, ,, used by the British Post Office	—	173	I bis	368
,, Voice, Artificial Mouth, Definition of	—	166	I bis	349

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Attenuation :				
Balance	169	—	I bis	58
„ International circuit. (Active return loss)	—	113	I bis	156
„ Measurement	384	—	IV	81
„ National System	—	113	I bis	156
Constant. (See " Constant.")				
Definition	167	—	I bis	54
Distortion. (See " Distortion Attenuation.")				
Echo	170	—	I bis	59
„ Measurement	388	—	IV	87
Limits for Carrier Telephony	238	—	I bis	183
Measurement	370	—	IV	57
	384	—	IV	81
	404	—	IV	115
Non-reflection	170	—	I bis	58
„ „ Measurement	387	—	IV	87
Overall	169	—	I bis	57
International terminating and transit circuit	227	107	I bis	146
Repeater section of open wire line for broadcast circuit	244	—	III	160
V.F. Telephony, Effect on by carrier system	239	—	I bis	185
Overall Measurement	380	—	IV	74
Open Wire Lines	272	—	III	210
Regularity	170	—	I bis	58
„ Measurement	387	—	IV	87
„ Open Wire Lines	270	—	III	206
„ Repeater Section	—	113	I bis	157
Variation with Amplitude Measurement	404	—	IV	115
Audibility :				
Normal threshold	60	—	I	90
Threshold	60	—	I	89
Audiogram :				
Noise	61	—	I	91
Auditors :				
1934	21	—	I	29
1936	—	19	I bis	33
Auditory :				
Sensation area	61	—	I	91
Babble	174	—	I bis	64
Balance Attenuation. (See " Attenuation, balance.")				
Balancing Networks :				
Construction for Open-wire lines	275	—	III	216
Band Articulation. (See " Articulation, band.")				
Bar :				
Definition	59	—	I	87
Bel :				
Definition	58	—	I	86
	165	—	I bis	52
Bibliography on Telephone Transmission :				
Abbreviations	—	193	I bis	450
English	—	205	I bis	476
French	—	215	I bis	499
German	—	195	I bis	452

	Page No. English Edition		French Text	
	1934	1936	*Vol.*	*Page No.*
Booking a Call :				
Definition	551	—	V	21
Modification by Caller	585	—	V	78
Bookings :				
Serial Numbers	587	234	I bis	563
Exchange of, in busy period	585	—	V	79
Bourse. (See " Stock Exchange.")				
British Telephone Network, Organization	210	—	III	100
Broadcast Circuits :				
Adjustable correctors for temperature variation	—	127	I bis	199
Anti-distortion, adjustments	249	—	I bis	195
Cable characteristics	244	—	III	161
Capacity unbalance, reduction by screening	245	—	III	162
Crosstalk limits, near and far end	247	—	I bis	193
Cut-off frequency	244	—	III	161
Electrical conditions to be observed :				
(*a*) General characteristics	247	126	I bis	191
(*b*) Method of equalization and adjustment	248	127	I bis	194
Equalization	248	127	I bis	194
Frequency band to be transmitted	247	—	I bis	191
General principles	247	126	I bis	191
Levels	248	—	I bis	195
	250	—	I bis	197
Loading for	328	—	I	304
	—	147	I bis	267
Maintenance. (See " Maintenance.")				
Map	560	—	V	37
Noise	248	—	I bis	193
Non-linear distortion	247	—	I bis	192
Open wire lines, general principles	244	—	III	160
Phase distortion, limits	—	126	I bis	192
Point of origin	248	—	I bis	194
Power transmitted (maximum)	247	126	I bis	191
Preliminary testing period	534	—	I bis	445
Programme distribution	—	127	I bis	199
,, of tests	34	—	I	51
Psophometric voltage	248	—	I bis	193
Repeater output levels, limits of variation	250	127	I bis	196
Screened	244	—	III	161
	245	—	III	162
,, Effect of magnetic induction	245	—	III	163
,, Near and far end crosstalk	245	—	III	162
Testing, Dates	35	—	I	52
,, Designation of circuits used	35	—	I	52
,, Frequency of periodic maintenance	531	—	I bis	349
,, Frequency to be used for	34	—	I	51
Temperature variation. Compensation	247	—	I bis	193
	—	127	I bis	199
Transient phenomena	—	126	I bis	192
Use of hypsographs (Automatic Level Recorders)	35	—	I	52
	—	192	I bis	441
Voltage, maximum	249	—	I bis	195

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Broadcast Circuits (*continued*) :				
Volume	249	—	I bis	195
	—	126	I bis	191
Broadcast Repeaters. (See " Repeaters, Broadcast.")				
Broadcast Transmission over Land Lines :				
Admission	603	—	V	102
Chargeable time. Agreement	536	—	I bis	448
Charges	605	236	I bis	572
Control circuit	534	—	I bis	446
	604	—	I bis	571
General conditions	603	235	I bis	570
Maximum power (see alsc " Broadcast Circuit " Power) ...	535	—	I bis	448
Multiple relay	604	235	I bis	571
	608	237	I bis	578
Rates (see Charges).				
Renters. Preparatory period	534	—	I bis	445
Setting up and adjustment period	534	—	I bis	445
Setting up and restoration of circuits	533	192	I bis	443
Subscription Rate	607	—	V	112
Technical procedure and responsibility	532	—	I bis	442
Two-way transmission	605	—	I bis	573
Use of Telephone circuits	203	—	III	87
Volume Indicator	533	—	I bis	443
Brochure :				
International Telephony, Publication	568	—	V	51
Busy Hour :				
Agreed limits	613	—	V	121
Circuit or circuit group	552	—	V	23
Exchange	552	—	V	23
Cable :				
Characteristics for National System	277	—	III	220
Circuits in, not to be earthed	123	—	II bis	33
Factory lengths, Specification	320	—	I bis	256
For broadcast transmission	244	—	III	161
General Recommendations	277	—	III	220
Plumbing, Soldering and Drying (paraffin, Silica gel, etc.) ...	70	—	I	105
Sections of open wire lines	270	—	III	207
	282	—	III	229
Sheaths : Make up, Recommendations regarding impurities in metal	—	79	II bis	109
Sheaths : Elasticity and make up of alloys	—	79	II bis	110
Star Quad and Quad Pair	277	—	III	220
Test Points	277	—	III	221
Unloaded, for carrier telephony	234	—	I bis	160
	235	—	I bis	163
Cables :				
International. Map of	559	—	V	36
Submarine. Attenuation	279	—	III	223
,, Balance Attenuation	279	—	III	224
,, Carrier current and Two-Band Telephony ...	281	—	III	226
,, Crosstalk, near and far end	279	—	III	223

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Cables (*continued*) :				
Submarine. Distortion, Phase	279	—	III	223
,, Factory Lengths, Uniformity	279	—	III	223
,, General Conditions	278	—	III	222
,, Hysteresis losses	279	—	III	223
,, Level, Input and Output	278	—	III	222
,, Noise	278	—	III	222
,, Operating Conditions	279	—	III	224
,, Phantom circuits. Use of	281	—	III	228
,, Psophometric voltage	278	—	III	222
,, Stability	279	—	III	223
,, Stability, calculation	279	—	III	224
Call :				
Aircraft, forced landing	584	—	V	77
Avis d'appel	575	231	I bis	549
Booking	551	—	V	21
Conference	259	—	III	188
	584	—	V	76
	600	—	V	101
Definition	551	—	V	21
Demand for, Modification. Transmission during heavy traffic	585	—	V	78
Direct	552	—	V	24
Duration, Allowances, Registering and chargeable	613	—	V	121
Effective	551	—	V	22
Enquiries	582	—	V	73
Fixed time	575	—	V	61
Hearing difficulty, procedure	592	—	V	89
Indirect	553	—	V	24
International, priority of	586	—	V	80
Loudspeaker and Microphone facilities, Conditions	—	129	I bis	203
" No reply " charges	611	—	V	119
Paid by person called	581	233	1 bis	559
Percentage of Effective to Booked	551	—	V	22
Préavis	577	231	1 bis	553
Press Rates	601	—	V	102
Publicity	565	—	V	44
Serial number	587	234	I bis	563
Switched, Single and Double	553	—	V	25
Stock Exchange (Bourse)	581	233	I bis	557
Subscription	—	228	I bis	544
,, Charges	600	—	V	101
,, General conditions and charges	—	228	I bis	544
Telegraphic preparation	588	—	V	83
Test. Maximum duration	592	—	V	88
Toll (Trunk) Priority	258	—	III	185
Transit	553	—	V	24
Utilizing a radiotelephone circuit	610	—	V	116
Without préavis to subscriber referred to " absent subscribers' service "	596	—	V	94
Wrong Number	601	—	V	103
Call Office :				
Rates	601	—	V	102

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Canvassing :				
Cost	614	—	V	123
Capacity :				
Effective, Repeater section of cable	322	146	I bis	261
Unbalance	175	—	I bis	68
	323	146	I bis	262
Unbalance Limits	323	146	I bis	263
,, Measurements	419	—	IV	140
,, Reduction by screening	245	—	III	162
,, to Sheath, Measurement	422	—	IV	145
Carrier Circuits :				
Attenuation. Limits	238	—	I bis	183
Cross Modulation	267	—	I bis	225
Crosstalk, near and far end	238	123	I bis	183
Equivalent, limits	237	—	I bis	182
Frequency band to be transmitted	238	—	I bis	183
Intermodulation	267	—	I bis	225
Interconnection	239	—	I bis	185
Maintenance tests	427	—	IV	153
Measurements	424	—	IV	150
Psophometric E.M.F. Limits	239	—	I bis	184
Reflection Coefficient. Limits	239	—	I bis	184
Setting up	515	—	I bis	414
Superposed on Power lines. Connection to public network ...	—	43	II bis	34
Carrier Current :				
Use of	238	—	I bis	160
Carrier System :				
Constitution	237	—	I bis	180
Effect on attenuation of V.F. Telephony	239	—	I bis	185
Light and Extra light loaded cables	—	124	I bis	187
Open wire lines : Questionnaire	240	—	I bis	186
Open wire lines, Spacing of...	238	—	I bis	183
Oscillators	237	—	I bis	181
Carrier Telephony :				
Cross Modulation and Intermodulation	—	125	I bis	189
Crosstalk and other disturbances	238	123	I bis	183
Distortion Attenuation	238	—	I bis	183
Equivalent and levels	237	—	I bis	182
Frequencies, to be employed, 1, 2, 3 or 4 + 1 systems ...	—	124	I bis	187
Frequency distortion	238	—	I bis	183
General characteristics	236	124	I bis	180
Impedance	238	—	I bis	183
,, variations limits	238	—	III	150
Interconnections and Echoes	239	—	I bis	185
Light and Extra light loaded cables	—	124	I bis	187
Low frequency channels	239	—	I bis	185
Mixed lines	283	—	III	230
Model questionnaire for existing lines before establishing ...	240	—	I bis	186
Monitoring and adjustment	239	—	I bis	184
Non-linear crosstalk	—	125	I bis	188
Other characteristics of 2, 3 or 4 + 1 systems	—	124	I bis	188
Phantom circuits	240	—	I bis	185

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Carrier Telephony (*continued*) :				
Repeaters to be used for 2, 3 or 4 + 1 systems	—	124	I bis	188
Side band to be suppressed	237	—	I bis	181
	—	124	I bis	187
Signalling	239	—	I bis	185
Unloaded cable	234	—	I bis	160
	235	—	I bis	163
Voice Frequency Channels	239	—	I bis	185
Carrier Telephony, Two Band :				
Attenuation, Equivalent and Level	242	—	III	158
„ Non-linear. Limits	244	—	III	159
Crosstalk, near and far end. Limits	244	—	III	159
Definition	241	—	III	154
Economic considerations	242	—	III	156
Frequency band	242	—	III	157
Gain regulation. Limits	243	—	III	159
General principles	240	—	III	154
Impedance Variation. Limits	243	—	III	159
Oscillator	242	—	III	157
Technical considerations	242	—	III	157
Carrier Wave :				
Suppressed	237	124	I bis	181
	—	134	I bis	187
Chargeable Time :				
Agreement	596	—	V	95
Definition	554	—	V	27
Notification to Subscribers	613	—	V	121
Radio Links	610	—	V	116
Ticket Printing	614	—	V	121
Charges (see also "Rates"; and "Tariffs") :				
Applicable to "Wrong Number"	602	—	V	103
„ „ "No Reply"	611	—	V	119
Broadcast Transmission. (See "Broadcast Transmission.")				
International Telephony, general rules	598	234	I bis	566
„ „ Division of	599	—	I bis	568
Radio Link	598	—	I bis	566
Report, in connection with radio-telephone circuit	612	—	V	120
Transferred	581	233	I bis	559
Circuit Noise. (See "Noise.")				
Circuits :				
Broadcast. (See "Broadcast Circuits.")				
Instructions for Setting up and Maintenance	512	—	I bis	408
International, List of	556	225	I bis	532
	623	237	I bis	580
„ Recommendations concerning	269	—	III	205
„ Exchange to Local Exchange. Characteristics ...	254	—	III	180
Long. Recommendations concerning	234	114	I bis	160
Non-utilisation of, statistics	511	—	I bis	406
Radiotelephone :				
Automatic volume regulators	—	143	I bis	249
Chargeable time	610	—	V	116
Charges for preparation time	612	—	V	120
Connection by means of 4-wire land line	317	—	III	285

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Circuits (*continued*) :				
Radiotelephone :				
Frequency band	313	—	III	278
General conditions	313	—	III	277
International calls use	610	—	V	116
Land lines connected to	314	—	III	279
Mobile, connection with	317	—	III	286
Land network	317	—	III	286
Noise	314	—	III	279
Noise voltage limit	314	—	III	279
Overall equivalent	313	—	III	278
Phase distortion	314	—	III	279
Signal to noise ratio	314	—	III	278
Technical operator	610	—	V	116
	314	—	III	280
Terminal equipment	315	—	III	280
Voice operated switching device	314	—	III	280
Volume indicator	315	—	III	281
Setting up : Carrier current	515	—	I bis	414
„ „ Final tests and measurements	516	190	I bis	414
„ „ Frontier output level	514	—	I bis	412
„ „ Level diagram	514	—	I bis	412
	527	—	I bis	434
	528	—	I bis	437
„ „ Preliminary exchange of data	514	190	I bis	411
„ „ Preliminary tests and measurements	514	—	I bis	412
„ „ Singing point of two-wire repeaters	515	—	I bis	414
Screened. Broadcast transmission	245	—	III	161, 162
„ Magnetic Induction	246	—	III	163
„ Noise reduction	246	—	III	165
Telephone, Definition	552	—	V	23
„ Four-wire interconnection	236	—	III	147
„ Four-wire to two-wire : Operating methods	595	—	V	93
„ Tests	379	—	IV	73
„ Two-wire not admissible for picture telegraphy	250	—	III	174
„ Use of, for broadcast transmission	203	—	III	87
„ Use of, for picture telegraphy	250	—	III	174
Clicks (Noise), definition	174	—	I bis	65
Coefficient, Reflection. (See " Reflection Coefficient.")				
„ Sensitivity (Noise ratio)	—	40	II bis	28
Coils Heat. Characteristics	—	47	II bis	41
Comité Consultatif International Telephonique :				
Auditors :				
1934	21	—	I	29
1936	—	19	I bis	33
Accounts :				
1934	17	—	I	23
1936	—	19	I bis	33
Collaboration with International Telecommunications Union	547	—	V	15
Collaboration with Technical Organizations	547	—	V	14
Commissions de rapporteurs (C.R.) (see also " Commission de Rapporteurs ")	543	—	I bis	526
	545	—	I bis	529
Delegates to 10th Plenary Assembly, Budapest	5	—	I	5

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Comité Consultatif International Telephonique (*continued*) :				
Delegates to 11th Plenary Meeting, Copenhagen	—	7	I bis	15
Financial regulations	—	17	I bis	29
	545	225	I bis	530
General Secretary	543	—	I bis	527
	544	—	I bis	529
Management Report 1934 (Rapport de Gestion)	17	—	I	23
Management Report 1936 (Rapport de Gestion)	—	17	I bis	30
Organization	541	—	I bis	523
Plenary Meeting	542	—	I bis	525
	544	—	I bis	528
Plenary Meeting, Budapest. Minutes Chief Delegates Meeting	17	—	I	23
Plenary Meeting, Budapest. Minutes Opening Session ...	10	—	I	12
Plenary Meeting, Budapest. Minutes Closing Session ...	20	—	I	27
Plenary Meeting, Copenhagen. Minutes Chief Delegates meeting	—	17	I bis	29
Plenary Meeting, Copenhagen. Minutes Opening Session ...	—	14	I bis	25
Plenary Meeting, Copenhagen. Minutes Closing Session ...	—	21	I bis	35
Representation of Colonies, Protectorates and Mandated Territories	546	—	V	14
Representation of private Telephone Companies	546	—	V	13
Representation on committee of liaison between International Electrical Associations	547	—	V	15
Secretariat and SFERT Laboratory. Salary Revision	—	19	I bis	34
Secretariat. Regulations for Personnel	548	—	V	16
SFERT Laboratory	543	—	I bis	527
„ „ Regulations for Personnel	549	—	V	18
Commissions de rapporteurs (C.R.) :				
Chief Rapporteurs 1934–1935	23	—	I	31
„ „ 1936–1938	—	24	I bis	40
Composition 1934–1935	55	—	I	81
„ 1936–1938	—	313	I bis	719
Statutory Regulations	543	—	I bis	526
	545	—	I bis	529
1st C.R. Directives' Sub-Committee	—	28	II bis	8
1st C.R. Questions for Study (Interference)	—	239	I bis	584
2nd C.R. Questions for Study (Corrosion)	—	248	I bis	600
3rd C.R. Permanent Maintenance Sub-Committee	509	—	I bis	404
	532	—	I bis	442
	—	316	I bis	724
3rd, 4th and 5th C.R. Questions for Study (Transmission) 1934–1935	28	—	I	38
3rd, 4th and 5th C.R. Questions for Study (Transmission) 1937–1938	—	252	I bis	607
4th C.R. Permanent Committee for SFERT Laboratory ...	549	—	V	18
6th and 7th C.R. Questions for Study (Operation and Tariffs) 1934–35	49	—	I	73
6th and 7th C.R. Questions for Study (Operation and Tariffs) 1937–38	—	309	I bis	713
8th C.R. Formation	25	—	I	32
8th C.R. Questions for Study (Symbols) 1934–35	51	—	I	76
Compliance :				
Acoustic	63	—	I	93

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Conductor :				
Diameter, Notes on	234	—	I bis	161
Constant :				
Attenuation	65	—	I	96
	168	—	I bis	54
,, image	167	—	I bis	54
,, iterative	168	—	I bis	55
Conjugate attenuation	168	—	I bis	56
,, phase	169	—	I bis	56
,, transfer	168	—	I bis	55
Image phase	65	—	I	97
	167	—	I bis	54
,, transfer	167	—	I bis	54
Iterative phase	65	—	I	96
	168	—	I bis	54
Phase	168	—	I bis	55
Propagation	65	—	I	96
	168	—	I bis	55
Transfer	65	—	I	97
Wavelength	168	—	I bis	55
Constants, Electrical :				
Uniform distribution	234	—	I bis	161
Conventional via terminals, definition	198	—	III	78
Conversation :				
Length	554	—	V	27
	596	—	V	95
Correctors, Fading	—	145	I bis	253
Adjustable for broadcast circuits	—	127	I bis	199
Corrosion, Chemical :				
Buried cables	—	77	II bis	105
Cable in ducts, etc.	—	77	II bis	106
Definition	—	77	II bis	105
Lead and Alloys	—	77	II bis	105
Method of distinguishing from Electrolysis	—	78	II bis	107
Principal causes of	—	77	II bis	105
Questions of Protection (2nd C.R.)	—	248	II bis	127
Corrosion, Electrolytic. (See " Electrolysis.")				
Crew Factor :				
Correction of Articulation measurement	469	—	I bis	339
Definition	182	—	I bis	82
Crosstalk :				
A. T. and T. proposition in connection with minimum losses on four-wire circuits	40	—	I	61
Babble	174	—	I bis	64
Broadcast transmission, near and far end limits	247	—	I bis	193
Cable. General considerations (Table)	416	—	IV	134
Carrier circuits, near and far end	238	123	I bis	183
,, current, measurement	409	—	IV	123
,, telephony. Two band	244	—	III	159
Coupling, near and far end	174	—	I bis	65
Frequency curve	414	—	IV	132
Infra acoustic telegraphy	308	—	I bis	231
Intelligible and unintelligible	174	—	I bis	64

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Crosstalk (*continued*) :				
Inverted and uninverted	174	—	I bis	64
International circuit, near and far end, limits	—	114	I bis	158
Line transformers	332	—	I bis	282
Loading Coils	325	—	I bis	265
Measurement. Disturbing Generator	409	—	IV	124
„ Fixed frequency generator	410	—	IV	125
„ Mixed frequency generator	411	—	IV	127
„ Near and far end	404	—	IV	116
„ Receiving apparatus	412	—	IV	130
„ Table of conditions for different methods	416	—	IV	134
„ Use of psophometer filter	413	—	IV	132
Meter	183	—	I bis	83
„ Description	405	—	IV	117
Near and far end	174	—	I bis	65
Picture Telegraphy	174	—	III	176
Repeater section of cable	327	147	I bis	270
Screened circuits, near and far end	245	—	III	162
Submarine cables	279	—	III	223
Telegraphy on superposed circuits	309	—	I bis	234
Telex	—	138	I bis	236
Current :				
Direct, maximum on cable	477	—	IV	242
Cycle. Definition	58	—	I	85
Decibel and Decineper :				
Conversion tables	166	—	I bis	50, 51
Definition	58, 59 / 165	—	I / I bis	86 / 52
Definitions :				
Acoustic	58	—	I	85
Telephone transmission	165	—	I bis	49
Degea's carbon monoxide detector	68	—	I	102
Delay :				
International circuit. Total and average	553	—	V	25
Total Maximum	555	—	V	30
Delegates :				
List of, attending Xth A.P. Budapest 1934	5	—	I	5
List of, attending XIth A.P. Copenhagen 1936	—	7	I bis	15
Density :				
Sound energy	60	—	I	85
Dielectric Strength. Test for	—	148	I bis	278
" Directives "				
Protection	—	28	II bis	7
Sub-committee	—	28	II bis	8
Directory :				
Telephone	568	—	V	49
Distortion :				
Amplitude	172	—	I bis	62
Attenuation. Limits	227	—	I bis	149
„ Subscriber's apparatus. Measurement	430	—	IV	161
Delay	172	—	I bis	61

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Distortion (*continued*) :				
Frequency	172	—	I bis	61
	227	—	I bis	149
„ Measurement, circuits	396	—	IV	101
	404	—	IV	115
„ „ apparatus	430	—	IV	161
„ Transmission impairment	182	—	I bis	82
Harmonic. Broadcast Transmission, limits	247	—	I bis	192
„ Coefficient of	172	—	I bis	62
„ Measurement	403	—	IV	114
Measurement	396	—	IV	101
„ of Reduction of Transmission quality due to	472	—	IV	233
Non-linear	172	—	I bis	61
„ Broadcast Transmission, limits	247	—	I bis	192
„ Measurement	403	—	IV	114
„ Subscriber's apparatus. Measurement	431	—	IV	163
„ Syllabic articulation. Effect on	234	114	I bis	159
Phase	—	113	I bis	61
„ Broadcast transmission. Limits	247	—	I bis	192
„ Limitation	—	106	I bis	138
	—	113	I bis	157
„ Measurement	396	—	IV	102
„ Picture Telegraphy	251	—	III	175
„ Radio Links	314	—	III	279
Drainage :				
Electric	—	57	II bis	70
Earthing of telephone lines	—	43	II bis	33
Echo :				
American Telephone and Telegraph Co's proposition in connection with minimum working losses of two or four-wire circuits	39	—	I	57
Attenuation. (See " Attenuation, Echo.")				
Definition	170	—	I bis	59
General recommendations	—	112	I bis	155
Minimum admissible equivalent. Circuits without suppressors	—	117	1 bis	169
„ „ „ four-wire and two and four-wire circuits interconnected with suppressors	—	119	1 bis	173
Echo Suppressors :				
Analysis of disturbances caused by	29	—	I	42
Hangover time. Valve and relay types	—	112	I bis	155
	—	116	I bis	168
Local sensitivity	39	—	I	60
Notes concerning different types	—	115	I bis	165
Operating time, valve and relay types	—	116	I bis	167
Partial closing time valve and relay types	—	117	I bis	167
Picture Telegraphy, use for	251	—	III	174
Recommendations to use	—	112	I bis	155
Relay type	—	115	I bis	165
Sensitivity, valve and relay types	—	115	I bis	165
Specification	334	—	1 bis	285
Valve or rectifier types	—	115	I bis	165
Zero level sensitivity	39	—	I	57

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Electric Drainage and insulating joints...	—	57	II bis	70
Electro-Acoustic Index :				
Definition	178	—	I bis	74
Measurement	428	—	IV	157
Electrolysis :				
Co-operation with interested concerns	—	53	II bis	62
Committee for revision of recommendations	—	54	II bis	63
Electrical measurements	—	72	II bis	97
General information	—	53	II bis	62
Method of distinguishing from Chemical Corrosion	—	78	II bis	107
Protection of telephone cables. General History	—	55	II bis	64
Rail joints. Measurement of resistance	—	76	II bis	79
Recommendations :				
Calculation of return currents	—	66	II bis	88
„ „ rail voltage	—	56	II bis	68
General clauses	—	59	II bis	75
Measurement. Currents in cable sheath	—	72	II bis	97
Measurements. Earth currents	—	75	II bis	100
Measurement. P.D. and voltage gradient	—	75	II bis	101
„ Resistance of rail joints	—	76	II bis	66
Modifications to	—	55	II bis	278
Protection. Electric Drainage and insulating joints ...	—	57	II bis	70, 85
„ Electric Traction	—	61	II bis	77
„ Underground Cables	—	64	II bis	83
Testing methods	—	72	II bis	97
Electrostatic formulæ for determining electric induction	—	32	II bis	15
Enquiries, request for information	582	—	V	73
Equalization :				
Broadcast circuits	248	127	I bis	194
Carrier repeaters	267	—	I bis	225
Two-wire repeaters	262	—	I bis	216
Equivalent :				
Carrier System limits	237	—	I bis	182
„ telephony. Two Band	242	—	III	158
International. Terminating and Transit circuits	227	107	I bis	146
Limits of variation with frequency, two and four-wire circuits ...	228	109	I bis	149
Loudness	61	—	I	90
„ Contours	61	—	I	91
Measurement	520	—	I bis	424
	380	—	IV	74
	404	—	IV	115
Minimum Admissible	—	108	I bis	147
„ „ Circuits without echo-suppressors	—	117	I bis	169
„ „ Four-wire, two and four-wire circuits interconnected with suppressors	—	119	I bis	173
Overall for open wire lines	270	—	III	207
Picture Telegraphy	251	—	III	174
Reference :	180	—	I bis	78
International. Limit between two operators or between operator and subscriber	199	—	I bis	135
International. Overall limits between two subscribers ...	197	105	I bis	133
Measurement	443	—	IV	168

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Equivalent (*continued*) :				
Reference :				
National Sending and Receiving	198	105	I bis	133
	227	107	I bis	146
Relative	180	—	I bis	79
V.F. Telegraphy	311	142	I bis	245
Equivalent (Effective Transmission) :				
Definition	182	—	I bis	82
Germany	—	93	I bis	110
Great Britain	—	91	I bis	106
Measurement	470	—	IV	231
Recommendations regarding	185	84	I bis	89
Rumania	—	95	I bis	114
SFERT Laboratory. Proposed tests	—	97	I bis	117
U.S.A.	194	—	I bis	103
European Switching Scheme :				
Mixed Commission. Constitution	—	24	I bis	42
	—	315	I bis	723
Provisional principles	—	82	I bis	86
Recommendations	184	82	I bis	84
Exchange :				
Busy Hour	552	—	V	23
Devices for protection of personnel and apparatus of	—	48	II bis	43
Local	254	—	III	180
Long distance	256	—	III	183
Telephone	253	—	III	177
Facilities available to the public	572	—	V	56
Factor :				
Force	65	—	I	98
Telephone form, of voltage	—	31	II bis	12
	—	33	II bis	16
Factors :				
Weighting. Table of	—	36	II bis	20
	484	—	IV	253
Fading Corrector	—	145	I bis	253
Fault Localization. (See " Maintenance.")				
Feeling :				
Normal Threshold	61	—	I	90
Threshold	60	—	I	90
Filter :				
Band elimination ; Composite wave ; High Pass ; Low Pass ; Band Pass	67	—	I	100
Low Pass for Articulation measurements	465	—	I bis	333
Psophometer. Broadcast circuits	487	—	IV	258
„ Use in Crosstalk measurements	413	—	IV	132
Form Factor, telephone, of voltage	—	31	II bis	12
	—	33	II bis	16
France, Switching programme	220	—	III	117
Frequency :				
Anti-resonant	63	—	I	94

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Frequency (*continued*) :				
Cut-off	65	—	I	97
„ Broadcast transmissions	245	—	III	161
„ Calculation	327	—	I bis	272
Definition	58	—	I	86
	167	—	I bis	53
Limitation. Effect on Transmission	—	85	I bis	91
Natural	63	—	I	94
Resonant	63	—	I	94
Signalling and Telegraphic. General Schematic	202	—	III	86
Testing	—	192	I bis	441
Frequency Band :				
Broadcast transmission	247	—	I bis	191
	200	—	III	80
Carrier Telephony	—	124	I bis	187
„ „ Two Band	242	—	III	157
Effectively Transmitted. Speech	200	—	III	80
„ „ Broadcast	247	—	I bis	191
	200	—	III	80
Open-wire lines	272	—	III	209
Repeaters. Broadcast	265	—	I bis	223
„ Two-wire	261	—	I bis	215
„ Four-wire	263	—	I bis	218
Speech	237	—	I bis	181
	200	—	III	80
Telegraphy. Infra acoustic	237	—	I bis	181
„ Ultra acoustic	237	—	I bis	181
	309	—	I bis	233
Frequency Bands. Characteristic (of vocal sounds)	182	—	I bis	81
„ Distortion. (See " Distortion, Frequency.")				
Frontier Circuits. Inter Administration co-operation on	331	147	I bis	276
Frying. (See " Noise.")				
Fuses :				
Characteristics	—	46	II bis	39
Gain :				
Effective	169	—	I bis	56
Insertion	169	—	I bis	57
Repeater. Measurement	531	—	I bis	440
	382	—	IV	79
Set. Description	183	—	I bis	83
	382	—	IV	79
Gas Detectors :				
Degea's carbon monoxide detector	68	—	I	102
Nellisen's gas detector	68	—	I	102
Osmometre	73	—	I	111
Palladium chloride indicator	71	—	I	107
Strache's gasoscope	68	—	I	102
Tests	67	—	I	101
German Long Distance Network. Organization	206	—	III	92
Guiding Principles concerning Protection. (See " Directives.")				

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Harmonic Distortion. (See "Distortion.")				
Harmonic Telegraphy. (See "Telegraphy Voice Frequency.")				
Heat Coils	—	47	II bis	41
Hertz	167	—	I bis	53
Impairment:				
Frequency distortion transmission	182	—	I bis	83
Noise transmission	183	—	I bis	83
Impedance:				
Acoustic	62	—	I	92
Blocked	66	—	I	98
Characteristic	167	—	I bis	54
,, Calculation	328	—	I bis	276
Conjugate	64	—	I	95
	167	—	I bis	53
Image	65	—	I	97
	167	—	I bis	53
Iterative	65	—	I	97
	167	—	I bis	53
Limits of International Circuits	226	—	I bis	145
Measurements	384	—	IV	81
Mechanical	62	—	I	92
Motional	66	—	I	98
Normal	66	—	I	98
Transfer	64	—	I	95
	167	—	I bis	53
Unbalance to earth. Measurement	419	—	IV	140
Unit Area	62	—	I	92
Variation. Mixed lines	283	—	III	232
,, Limits. Carrier Telephony	238	—	I bis	183
,, ,, Two Band Telephony	243	—	III	159
Impulse Meter	491	164	I bis	344
Indicators, chargeable time	613	—	V	121
Inertance. Acoustic	62	—	I	93
Induction:				
Electric	—	32	II bis	15
,, Electrostatic formulæ for determining	—	32	II bis	15
Magnetic. Effect on screened circuits	245	—	III	163
Power	174	—	I bis	64
,, Protection against	—	28	II bis	7
Insertion:				
Loss or gain	64	—	I	96
	169	—	I bis	57
Loss. Measurement	373	—	IV	63
Insulating Joints	—	57	II bis	70
Intelligibility:				
Definition	181	—	I bis	81
Words and phrases	61, 62	—	I	91, 92
	182	—	I bis	81

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Intensity :				
Level. Sound	60	—	I	88
Sound Measurement	474	—	IV	236
Interconnection, carrier circuits	239	—	I bis	185
Intermodulation, carrier repeaters	267	—	I bis	225
Interference :				
Earthing telephone lines	—	43	II bis	33
Questions of protection (1st C.R.)	—	239	II bis	111
Interfering Effect :				
Value at different frequencies	485	—	IV	253
	—	36	II bis	20
Interfering voltage. Objective measurement of equivalent	—	39	II bis	25
International Circuits for ordinary Telephony :				
Crosstalk and other disturbances	—	114	I bis	158
Echo effects	—	112	I bis	155
Frequency distortion	227	—	I bis	149
Impedance	226	—	I bis	145
Line Noise	233	—	I bis	158
Nomenclature	556	225	I bis	532
Non-linear distortion	233	114	I bis	159
Operating	587	—	V	80
Periodical observation on	620	—	V	131
Propagation time	232	113	I bis	157
Relative levels	—	109	I bis	150
Speed of answer interval	554	—	V	26
Stability	—	113	I bis	156
Terminal equivalent	—	107	I bis	146
Transient phenomena	—	113	I bis	157
Transit equivalent	227	—	I bis	146
International Circuits :				
Brief specification for	526	—	I bis	433
Final documents and maintenance	516	—	I bis	415
Instructions for the setting up and maintenance of	512	—	I bis	408
Level diagrams of	527	—	I bis	434
Maintenance of	512	—	I bis	408
Programme of periodic tests	529	192	I bis	438
Setting up	514	—	I bis	411
Statistics of non-utilisation of	530	—	I bis	439
International Switchboard :				
General conditions and operator's instruments	257	—	III	184
Monitoring position. General conditions	258	—	III	186
„ „ Impedance and Transmission losses ...	259	—	III	187
Transmission losses	257	—	III	185
International Telephone Service :				
Decentralisation	555	—	V	29
Establishment between two countries	562	—	V	40
European Switching Plan. Provisional principles	—	82	I bis	86
Extension	561	—	V	39
Operating. List of phrases	595	—	V	94
Publicity expense	614	—	V	123
Publication of booklets	568	—	V	51
Transmission Quality. Criterion	—	84	I bis	88

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Jointing, electric in the presence of gas	70	—	I	105
Junction Lines and Local Exchanges :				
Recommendations	254	—	III	180
Level :				
Absolute	173	—	I bis	63
Broadcast circuits	248	—	I bis	195
	250	—	I bis	197
Carrier Telephony. Interconnecting circuits. Allowable variation	239	—	I bis	185
„ „ Limits	237	—	I bis	182
„ „ Two Band	243	—	III	158
Definition	173	—	I bis	62
Diagram	514	—	I bis	412
	527	—	I bis	434
	528	—	I bis	437
Expected	173	—	I bis	63
Frontier station limits, four-wire circuit	229	—	I bis	154
Intensity	60	—	I	89
Maximum and minimum on four-wire circuit	230	—	I bis	150
„ „ „ „ two-wire circuit	231	—	I bis	154
Measurement	381	—	IV	76
Picture Telegraphy	251	—	III	174
Relative...	—	109	I bis	150
	173	—	I bis	62
Sensation	61	—	I	90
Signalling. Limits	201	—	I bis	139
Transmission diagrams	173	80	I bis	63
„ Measuring instruments. Graduation	173	—	I bis	63
Lightning Protectors	—	47	II bis	41
Line Scratches (noise)	174	—	I bis	64
Lines :				
Emergency	566	226	I bis	539
„ for extending Radio link	567	—	V	49
International. Recommendations	269	—	III	205
Leasing International, not comprising submarine sections ...	583	234	I bis	561
Mixed. Loading for Carrier Telephony	283	—	III	230
„ General conditions	281	—	III	228
„ Impedance variations	283	—	III	232
Loading :				
Carrier and Radio Broadcast circuits. Table A	328	—	I bis	273
Circuits for voice frequency Telephony :—				
International. Table B	329	147	I bis	274
National System. Table C	330	—	I bis	275
Coils. Specifications	324	146	I bis	265
Extra-light. Use	234	—	I bis	160
Mixed lines	282	—	III	228
Notes on	234	—	I bis	160
Open wire lines	269	—	III	205
Pots	324	—	I bis	265
Types. General remarks	327	—	I bis	272

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Logatom :				
Articulation	62	—	I	92
	181	—	I bis	81
Compilation of list	461	—	I bis	326
Definition	181	—	I bis	81
To be used	459	161	I bis	320
Long circuits :				
Recommendations	—	114	I bis	160
Loss :				
Active Return. Definition	232	—	I bis	59
„ „ Limits. Measurement	387	—	IV	87
„ „ „ National system	—	113	I bis	156
Equivalent net	169	—	I bis	57
Insertion	64	—	I	96
	169	—	I bis	57
„ Measurement	373	—	IV	63
Net. Variation with Amplitude	172	—	I bis	62
Return. Active and Passive	170	—	I bis	58
Structural Return. Measurement	388	—	IV	87
„ „ two-wire circuit	—	113	I bis	157
Terminal Return	—	117	I bis	170
Transducer	64	—	I	96
	169	—	I bis	57
Variation. Definition proposed by A.T. & T. Co.	41	—	I	63
Losses :				
Exchange. Measurement	374	—	IV	63
Minimum working, two or four-wire circuit. Proposition of A. T. & T. Co.	38	—	I	57
Loudness :				
Contours. Equivalent	61	—	I	91
Definition	61	—	I	90
Equivalent	61	—	I	90
Loudspeaker :				
Bell System. Proposals and instructions for use	—	132	I bis	207
	—	134	I bis	211
British Administration proposals	—	133	I bis	209
Definition	66	—	I	99
German Administration. Proposals and Instructions for use	—	130	I bis	204
Installation in noisy rooms	—	133	I bis	209
International Telephone Conversations. Conditions for use	—	129	I bis	203
Madrid Convention :				
Extracts	541	—	I bis	523
Maintenance :				
Broadcast circuits	531	192	I bis	440
Broadcast circuits : Hypsographs, Use of	—	192	I bis	445
„ „ Marking	536	—	I bis	448
„ „ Modifications	532	—	I bis	441
„ „ Periodic Tests. Programme	531	192	I bis	440
Broadcast transmission	531	—	I bis	440
Carrier circuits	427	—	IV	153
Circuits used for voice frequency telephony	509	—	I bis	403

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Maintenance (*continued*) :				
Controlling Office	509	—	I bis	404
Fault Localisation : Crosstalk	524	—	I bis	430
„ „ Defective Transmission	523	—	I bis	429
„ „ General principles and methods	523	—	I bis	428
„ „ General procedure	510	—	I bis	405
„ „ Noise	523	—	I bis	429
„ „ Signalling	523	—	I bis	429
„ „ Singing	524	—	I bis	429
Fault Returns	511	—	I bis	406
	524	—	I bis	430
	530	—	I bis	439
International Circuits	512	—	I bis	480
Level Diagram	514	—	I bis	412, 415
	527	—	I bis	434
	528	—	I bis	437
"List of Phrases" to be used	509	—	I bis	403
Patrol of international open wire lines	272	—	III	211
Periodic Tests : Frequency	518	—	I bis	418
„ „ Group System	520	—	I bis	424
„ „ Impedance	522	—	I bis	426
„ „ Intervals of, in all repeater stations	—	192	I bis	421
„ „ Methods	520	191	I bis	424
„ „ On completed circuits	517	191	I bis	416
„ „ On repeaters	517	191	I bis	417
„ „ Organisation	517	191	I bis	416
„ „ Overall equivalent and levels	520	191	I bis	422
„ „ Power supply	522	—	I bis	426
„ „ Programme	511	—	I bis	406
	529	—	I bis	438
„ „ Repeater Gain	522	—	I bis	426
„ „ Signalling	521	—	I bis	425
„ „ „ Apparatus	522	—	I bis	427
„ „ Singing Point	522	—	I bis	426
„ „ Speech	521	—	I bis	426
„ „ Stability	522	—	I bis	426
„ „ Use of T.M.S. recording sets (Hypsographs) ...	35	—	I	52
	—	191	I bis	417
„ „ Valves	522	—	I bis	427
„ „ Carrier circuits. Frequency	522	—	I bis	427
„ „ „ „ Intensity	523	—	I bis	427
„ „ „ „ Levels	522	—	I bis	427
„ „ „ „ Synchronisation	522	—	I bis	427
„ „ „ „ Sub-controlling office... ...	510	—	I bis	405
Permanent Sub-Commission	509	—	I bis	404
	532	—	I bis	442
Private Wires	254	—	III	179
Sub-controlling Office	510	—	I bis	404
Ultra Acoustic Telegraph circuits	—	192	I bis	430
Voice frequency „ „	524	—	I bis	431
Management Report : 1934	17	—	I	23
1936	—	17	I bis	30

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Manholes :				
Lighting	69	—	I	103
Plumbing, etc.	70	—	I	105
Safety lamps	69	—	I	104
Ventilation	75	—	I	115
Working precautions	67	—	I	101
Masking effect of sound	61	—	I	90
Measurements :				
With Alternating Currents : Quadripoles	370	—	IV	57
" " " Subscriber's Telephone Apparatus	428	—	IV	157
" " " Telephone Circuits	379	—	IV	73
With voice and ear (human or artificial) : Articulation	459	161	I bis	320
" " " " " " " Reference equivalents	433	—	IV	168
" " " " " " " Volume	433	—	IV	167
Carrier. (See " Carrier.")				
Crosstalk. (See " Crosstalk.")				
Distortion. (See " Distortion.")				
Earth and sheath currents. (See " Electrolysis.")				
Impedance. (See " Impedance.")				
Psophometric E.M.F. (See " Psophometric E.M.F.")				
Measuring Apparatus. (See " Testing Apparatus.")				
Measuring Set :				
Gain	183	—	I bis	83
Impedance Unbalance	384	—	IV	81
Noise	418	—	IV	137
Noise ratio	424	—	IV	149
Recording Transmission : (Hypsograph)	183	—	I bis	83
" " Attenuation measurement	371	—	IV	59
" " Attenuation variation with amplitude Measurement	404	—	IV	116
" " Balance Attenuation	384	—	IV	83
" " Characteristics	480	—	IV	246
" " Crosstalk-frequency curve	414	—	IV	132
" " Equivalent and Level	381	—	IV	78
" " Equivalent-frequency curve	396	—	IV	101
" " Propagation time	400	—	IV	109
" " Singing Point and stability	391	—	IV	93
Reflection	388	—	IV	87
Return loss	384	—	IV	81
Transmission	183 373	— —	I bis IV	83 63
Message recording Systems :				
Characteristics	—	128	I bis	200
Meter :				
Circuit noise	183	—	I bis	83
Crosstalk	183	—	I bis	83
Room noise	474	—	IV	238
Sound	183 —	— 181	I bis I bis	83 384
Microbar	59	—	I	87
Microphone	66	—	I	98
Minutes :				
Chief Delegates' Meeting XIth AP 1936	—	17	I bis	29

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Minutes (*continued*) :				
Closing meeting XIth AP 1936	—	21	I bis	35
Opening meeting XIth AP 1936	—	14	I bis	25
Monitoring equipment :				
General requirements	258	—	III	186
Mouth, Artificial	—	164	I bis	346
Multichannel Carrier Telephony. (See " Carrier.")				
Music circuit. (See " Broadcast circuit.")				
Music Repeater. (See " Repeater Broadcast.")				
Neper :				
Conversion Tables	166	—	I bis	50, 51
Definition	59	—	I	86
	165	—	I bis	49
Netherlands. Switching programme	224	—	III	126
Net loss. (See " Equivalent and Loss.")				
Network :				
Equivalent	66	—	I	99
For open wire lines, Construction of	275	—	III	216
Noise :				
Audiogram	61	—	I	91
Babble	174	—	I bis	64
Battery supply circuits	174	—	I bis	64
Broadcast Circuits, psophometric voltage. Limits	248	—	I bis	193
Clicks	174	—	I bis	65
Contact	174	—	I bis	64
Definition	173	—	I bis	63
E.M.F.	—	31	II bis	12
	—	33	II bis	16
Frying	173	—	I bis	64
Impairments. (See " Noise : Transmission Impairment.")				
Induced	174	—	I bis	64
Infra acoustic Telegraphy, resulting from	308	—	I bis	230
Limits for international circuits	233	—	I bis	158
Line	173	—	I bis	64
Line, Objective measurement	—	34	II bis	18
Line scratches	174	—	I bis	64
Measuring set	415	—	IV	136
Meter	183	—	I bis	83
,, American, zero reference	—	88	I bis	98
Objective measurement	—	34	II bis	18
	418	—	IV	138
Picture Telegraphy	252	—	III	176
Ratio	—	40	II bis	28
Radio circuits (intermediate or link)	314	—	III	279
Reduction by screening	246	—	III	165
Ripple	174	—	I bis	64
Room	173	—	I bis	63
Room. Effect on quality of telephone transmission	—	104	I bis	128
Room. Reference, for telephonometric tests	—	154	I bis	292
Subjective measurement	417	—	IV	136

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Noise (*continued*) :				
Submarine cables	278	—	III	222
Telegraph	174	—	I bis	65
Telex	—	145	I bis	236
Transient	174	—	I bis	64
Transmission Impairment	183	—	I bis	82
	—	85	I bis	91
„ „ Measurement	472	—	IV	233
Transmitter	173	—	I bis	64
„ Measurement	447	—	IV	194
Ultra acoustic Telegraphy	308	137	I bis	232
Valve	173	—	I bis	64
Voltage	—	31	II bis	12
	—	33	II bis	16
„ Limit. Repeater Power Plant	334	—	I bis	286
„ Maximum on International circuit	233	—	I bis	158
Non-linear Distortion. (See " Distortion.")				
Nomenclature of International circuits	556	225	I bis	532
No reply. Charges applicable	611	—	V	119
Numbers, Enunciating subscribers	587	—	V	81
Open Wire Lines :				
Atmospheric and Temperature correction	204	—	III	88
	270	—	III	208
Attenuation	272	—	III	210
„ Regularity	270	—	III	206
Balancing Networks. Construction	275	—	III	216
Broadcast circuit. Attenuation of Repeater section	244	—	III	160
„ Transmission. General rules	244	—	III	160
Cable sections of	282	—	III	229
Carrier equipment. Spacing	238	—	I bis	183
„ system. Questionnaire	240	—	I bis	186
Conductor resistance unbalance	271	—	III	208
Construction. General rules	269	—	III	205
Electrical characteristics	270	—	III	206
Frequency band	271	—	III	209
General characteristics	269	—	III	205
Impedance variation	271	—	III	208
Insulation	271	—	III	210
Leakance	271	—	III	208
Loading	269	—	III	205
Mechanical characteristics	269	—	III	206
Noise voltage : Maximum on International circuit	233	—	I bis	158
Overall equivalent	270	—	III	207
Patrolling	272	—	III	211
Protection against Power Lines	271	—	III	209
Setting up. General rules	269	—	III	205
Stability	270	—	III	207
	271	—	III	209
„ Calculation	273	—	III	212
Temperature correction	204	—	III	88
	270	—	III	208

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Open Wire Lines (*continued*) :				
Test points	272	—	III	210
Transpositions	271	—	III	209
	273	—	III	212
Wide Band Transmission	272	—	III	211
Operating and Rates :				
List of Recommendations concerning	—	330	1936 Index	30
Operators :				
Testing teams of, for articulation measurements	—	163	I bis	324
	467	—	I bis	335
Training and Service Instructions for telephone	597	—	V	96
Organisations co-operating with the C.C.I.F. Representatives ...	—	12	I bis	22
Oscillators :				
Carrier systems	237	—	I bis	181
Two Band Telephony	242	—	III	157
Osmometre. Apparatus for gas detection	73	—	I	111
Palladium chloride indicator for gas in man-holes	71	—	I	107
Peak Indicator. (See " Testing Apparatus.")				
Period :				
Definition	58	—	I	85
Natural	63	—	I	94
Periodic Tests. (See " Maintenance.")				
Phase Constant. (See " Constant.")				
„ Distortion. (See " Distortion.")				
Phon	61	—	I	90
	474	—	IV	237
Phrases :				
Test, for different languages	354	—	I bis	290
Used in maintenance of International circuits	509	—	IV	313
„ „ operating International circuits	595	—	V	94
Picture Telegraphy. (See " Telegraphy.")				
Power :				
Acoustic. Average	59	—	I	88
Definition	178	—	I bis	75
	179	—	I bis	76
Maximum. Broadcast Transmission	—	126	I bis	191
	247	—	I bis	195
„ Picture Telegraphy	251	—	III	175
„ Infra acoustic Telegraphy	307	—	I bis	230
„ Ultra acoustic Telegraphy	309	—	I bis	232
„ Telex	—	138	I bis	236
„ Voice Frequency Telegraphy	309	—	I bis	234
Speech. Average	61	—	I	91
„ Instantaneous	61	—	I	91
„ Peak	61	—	I	91
„ Phonetic	61	—	I	91
Supply. Repeaters. Measurements	396	158	I bis	305
„ Variations limits	262, 263	—	I bis	216, 219
	312	—	III	274
Power Lines :				
Equivalent disturbing voltage and current of	—	31	II bis	13
	—	34	II bis	17

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Power Lines (*continued*) :				
Telephone circuits on, connection to public network	—	43	II bis	34
„ form factor of voltage of	—	31	II bis	12
	—	33	II bis	16
Unbalance to Telephone lines. Measurement of	423	—	IV	147
Power Plant :				
Repeater. Specifications	334	150	I bis	286
Personnel of telephone exchanges, Instructions for	597	—	V	96
Press :				
Rates	601	—	V	102
Pressure :				
Excess	59	—	I	87
Sound	59	—	I	87
Static	59	—	I	87
Private Wire :				
International	583	234	I bis	561
„ Rates	583	234	I bis	563
Maintenance	254	—	III	179
Programme Transmission Circuits. (See " Broadcast circuit.")				
Programme Distribution (Radio-diffusion)	—	127	I bis	199
Propagation Constant. (See " Constant.")				
Propagation Time :				
Limits	200	105	I bis	137
	232	113	I bis	157
Measurements	396	—	IV	102
Propagation Speed :				
Calculation	328	—	I bis	276
Recommendations	232	113	I bis	157
	234	—	I bis	159
Protection :				
Chemical corrosion	—	77	II bis	105
Devices. Principal characteristics	—	46	II bis	38
" Directives " (Guiding principles)	—	28	II bis	7, 9
„ sub-committee	—	28	II bis	8
Electrolysis. (See " Electrolysis.")				
Electrostatic formulæ for	—	32	II bis	15
Ideal device	—	45	II bis	37
Open wire lines against Power lines	271	—	III	209
Power Induction	—	28	II bis	7
Principles	—	44	II bis	36
Protectors. Characteristics	—	45	II bis	38
„ Heat Coils	—	47	II bis	41
„ Lightning	—	47	II bis	40
„ Symbols	—	48	II bis	43
Systems in use. Diagrams	—	48	II bis	44
Short circuit currents	—	33	II bis	15
Protective measures applicable to underground cable networks ...	—	64	II bis	83
„ „ „ to traction networks	—	61	II bis	77
Psophometer :				
Calibration	—	37	II bis	24
Construction	—	37	II bis	24
Definition	183	—	I bis	83
Details required by C.C.I.F.	—	38	II bis	25

	Page No. English Edition		French Text	
	1934	1936	*Vol.*	*Page No.*
Psophometer (*continued*):				
Existing. Operating and Constructional details	—	38	II bis	26
Filter. Broadcast circuits	487	—	IV	258
„ Crosstalk measurements	413	—	IV	132
„ Telephone circuits	485	—	IV	252
General principles	—	35	II bis	19
	484	—	IV	252
Impedance	—	35	II bis	21
Method of use	—	38	II bis	24
	418	—	IV	138
	486	—	IV	257
Measuring instrument	—	35	II bis	21
Sensitivity	—	36	II bis	21
Specification of principles	—	35	II bis	19
	485	—	IV	252
Table of graduations. C.C.I.F. and A. T. & T. Co.	79	—	I	123
Tolerances	—	36	II bis	21
Weighting Table	—	36	II bis	20
	485	—	IV	253
Psophometric E.M.F. and Voltage:				
Broadcast circuits	248	—	I bis	193
„ repeater	266	—	I bis	225
Calculation of, caused by D.C. Traction lines	—	39	II bis	27
Carrier circuit, limit	239	—	I bis	184
Definition	—	33	II bis	16
	175	—	I bis	65
Effect on minimum permissible level	—	112	I bis	152
„ „ „ „ level of V.F. telephony ...	—	110	I bis	154
Infra acoustic Telegraphy	308	—	I bis	230
Limit for International Circuits	233	—	I bis	158
Measurement	—	34	II bis	18
Submarine cable	278	—	III	222
Ultra acoustic Telegraphy	309	—	I bis	232
Quad:				
Capacity unbalances	176	—	I bis	71
Definition	176	—	I bis	70
Quadripole:				
Tests on	370	—	IV	57
Questions for Study. 1935-1936:				
1st Commission de rapporteurs. (Protection against interference)	25	—	I	34
2nd Commission de rapporteurs. (Protection against corrosion)	27	—	I	37
3rd, 4th and 5th Commissions de rapporteurs. (Transmission)	28	—	I	38
6th and 7th Commissions de rapporteurs. (Operating and Rates)	49	—	I	73
8th Commission de rapporteurs. (Symbols)	51	—	I	76
Questions for Study. 1937-1938:				
1st Commission de rapporteurs. (Protection against interference)	—	239	I bis	584
			II bis	111
2nd Commission de rapporteurs. (Protection against corrosion)	—	248	I bis	600
			II bis	127
3rd, 4th and 5th Commissions de rapporteurs. (Transmission) ...	—	252	I bis	607
6th and 7th Commissions de rapporteurs. (Operating and Rates)	—	309	I bis	713
Mixed Committee for General European Toll Plan	—	309	I bis	713

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Radiotelephony. (See also " Circuits Radio Telephone "):				
Co-ordination with Telephony	313	143	I bis	249
Fading correctors	—	145	I bis	253
Sensitivity to Noise	—	144	I bis	251
Volume regulators	—	143	I bis	249
Radio Diffusion. (Programme Distribution)	—	127	I bis	199
Rail Joints:				
Measurement of resistance	—	76	II bis	79
Rates and Operating:				
List of Recommendations concerning	—	330	1936 Index	30
Reactance: Acoustic	62	—	I	93
Reaction Suppressors. (See " Echo Suppressors.")				
Receiver:				
Efficiency measurement	428	—	IV	157
	432	—	IV	166
Telephone, definition	66	—	I	99
Receiving Systems (and Transmitting systems), Relative efficiency ...	178	—	I bis	74
Recommendations:				
List of all C.C.I.F. in force at January 1st, 1937	—	317	1936 Index	5–32
Recording T.M.S. (See " Measuring Set.")				
„ Systems of Telephone message or conversations ...	—	128	I bis	200
Rectifiers:				
Reduction of disturbing voltage of	—	41	II bis	30
Six phase. Tests by SFERT Laboratory	—	102	I bis	126
Tests	—	41	II bis	31
Reference Equivalent. (See " Equivalent.")				
„ Room Noise	—	154	I bis	292
Reference System:				
European Master Telephone Transmission (SFERT)	186	—	I bis	89
Object	344	—	IV	11
SFERT. Characteristic Curves	351	—	IV	23
„ Calibration of working standards	354	—	IV	31
„ „ „ SETAC	355	—	IV	31
	361	—	IV	43
„ „ „ SETEM	358	—	IV	38
	361	—	IV	43
„ Regulation	350	—	IV	20
SETAC. Description...	363	—	IV	46
„ Use	434	—	IV	168
SETEM. Description	366	—	IV	52
„ Use	439	—	IV	180
Types	344	—	IV	12
Reference Systems. Telephone Transmission:				
Artificial lines	346	—	IV	16
General conditions	344	—	IV	12
Impedance	347	—	IV	16
Regulation	348	—	IV	16
Reference Systems, Telephone Transmission, Receiving:				
Acoustic output	348	—	IV	18
Efficiency regulation	348	—	IV	18
Impedance	348	—	IV	18

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Reference Systems, Telephone Transmission, Receiving *(continued)*:				
Method of Construction	349	—	IV	19
Non-linear distortion	348	—	IV	19
Relation between Electric voltage and Acoustic pressure	348	—	IV	18
Schematic	346	—	IV	15
Reference Systems, Telephone Transmission, Sending:				
Acoustic input	345	—	IV	13
Condenser microphone	347	—	IV	17
Efficiency Regulation	346	—	IV	13
Impedance	346	—	IV	13
Method of Construction	346	—	IV	16
Non-linear distortion	346	—	IV	16
Relation between Electric voltage and Acoustic pressure	346	—	IV	13
Schematic	345	—	IV	14
Reference Systems, Working Standards:				
Calibration	350	—	IV	20
General conditions and recommendations	349	—	IV	19
Reference Volume	490	—	I bis	343
	433	—	IV	167
Reflection Coefficient:				
Carrier telephony. Limits	239	—	I bis	184
Definition	170	—	I bis	58
Limits	—	113	I bis	156
Two-wire repeater, value	—	113	I bis	156
	262	—	I bis	216
Four-wire repeater	—	136	I bis	220
Regulators, Automatic volume	—	143	I bis	249
Repeaters:				
Broadcast: Crosstalk	266	—	I bis	224
„ Distortion	266	—	I bis	225
„ Frequency band	265	—	I bis	223
„ Gain Frequency characteristics	265	—	I bis	223
	244	—	III	161
„ Gain regulation	266	—	I bis	224
„ Gain variation with Output power	266	—	I bis	223
„ General characteristics	265	—	I bis	223
„ Impedance	266	—	I bis	224
„ Monitoring losses	266	—	I bis	224
„ Noise limits	266	—	I bis	224
„ Output levels	250	—	I bis	196
„ Output power	266	—	I bis	224
„ Psophometric voltage	266	—	I bis	225
„ Valves	245	—	III	161
„ Variation between gain-frequency curve and circuit equivalent	245	—	III	161
Carrier: Cross Modulation	267	—	I bis	225
„ Equalization	267	—	I bis	225
„ For 2, 3 or 4 + 1 systems	—	124	I bis	188
„ Gain regulation	267	—	I bis	225
„ General characteristics	267	—	I bis	225
„ Input and Output level	267	—	I bis	225
„ Insertion loss	267	—	I bis	225
„ Maximum gain	266	—	I bis	225

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Repeaters (*continued*):				
Carrier: Testing equipment	267	—	I bis	225
Cord Circuit: Advantages	256	—	III	183
„ „ Control by operators	257	—	III	184
„ „ General conditions	256	—	III	183
Four-wire (Voice frequency) Crosstalk	264	136	I bis	220
„ „ „ Distortion	264	136	I bis	221
„ „ „ Frequency band	263	—	I bis	219
„ „ „ Gain frequency characteristics ...	263	—	I bis	219
„ „ „ Gain regulation and variation limits	263	—	I bis	219
„ „ „ General characteristics	263	—	I bis	218
„ „ „ Impedance	—	136	I bis	219
„ „ „ Maximum output power	264	—	I bis	221
„ „ „ Monitoring. General rules ...	263	—	I bis	220
„ „ „ Monitoring losses	263	—	I bis	220
„ „ „ Power supply, regulation and variation limits	263	—	I bis	216
„ „ „ Reflection Coefficient	—	136	I bis	221
General characteristics	261	—	I bis	215
Joining different types of cable	264	136	I bis	221
Measurement of Gain	382	—	IV	79
„ „ Power Supply	396	—	IV	101
Pad Switching. Advantages	256	—	III	183
Two-wire: Crosstalk	262	135	I bis	217
„ Distortion	263	136	I bis	218
„ Equalisation	262	—	I bis	216
„ Frequency band	261	—	I bis	216
„ Gain Frequency. Characteristics	261	—	I bis	216
„ Gain regulation and variation limits	261	—	I bis	215
„ General characteristics	261	—	I bis	215
„ Impedance	262	—	I bis	216
„ Maximum output power	263	—	I bis	218
„ Monitoring. General rules	262	—	I bis	217
„ Monitoring losses	262	—	I bis	217
„ Power supply, regulation and variation limits ...	262	—	I bis	216
„ Reflection coefficient	—	113	I bis	156
	262	—	I bis	216
„ Singing point	261	—	I bis	215
	515	—	I bis	414
Repeater Section:				
Attenuation. Regularity	—	113	I bis	157
Broadcast circuit on open wire lines	244	—	III	160
Frontier crossing. Method of co-operation	331	147	I bis	276
Specification for, of cable	320	—	I bis	256
Repeater Stations:				
Frontier: Broadcast circuits...	250	—	I bis	198
„ Voice frequency Telegraphy	311	—	III	273
„ „ „ Telephony	229	—	I bis	150
Recommendations	261	—	I bis	215
Specification	332	—	I bis	282
Repetition Rate:				
Definition	182	—	I bis	82
Measurement	472	—	IV	234

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Report charges in connection with radio telephone circuits ...	612	—	V	120
Resistance, acoustic	62	—	I	93
Resonance :				
Amplitude	63	—	I	94
Note on different kinds	63	—	I	95
Velocity	63	—	I	93
Ringing Equipment. Voice frequency :				
Modification for Telex working	—	143	I bis	247
Specification. Essential clauses	202	—	I bis	139
Room Noise :				
Apparatus for the objective measurement of :				
Used by German Administration	—	182	I bis	386
„ „ Bell System	—	183	I bis	387
Measurements	—	181	I bis	385
Reference	—	154	I bis	292
„ as used by Japanese Administration	—	156	I bis	300
Routing :				
Emergency, Form to be used	—	227	V	45
Emergency (Voies de secours)	566	226	I bis	539
„ Rates	566	226	I bis	540
„ „ extending Radio link	567	—	V	49
Safety lamps	69	—	I	104
Screened circuits for Broadcast transmission :				
Magnetic induction	245	—	III	163
Noise reduction	246	—	III	165
Sensation :				
Area. Auditory	61	—	I	91
Level	61	—	I	90
Sensitivity coefficient (noise ratio)	—	40	II bis	28
SETAC. (See " Reference System.")				
SETEM. (See " Reference System.")				
SFERT. (See " Reference System.")				
SFERT Laboratory :				
Definition	543	—	I bis	527
Permanent Commission	549	—	V	18
Personnel	549	—	V	18
Shock, acoustic :				
Protection of operators	—	42	II bis	32
Short circuit current	—	29	II bis	10
„ „ „ Calculation of the effect of	—	33	II bis	15
Sidetone :				
Definition	180	—	I bis	79
Measurement	—	159	I bis	314
Reference Equivalent	181	—	I bis	80
Room Noise	181	—	I bis	79
Speech	181	—	I bis	79
Signal to Noise Ratio :				
Definition of useful signal voltage	175	80	I bis	66
Signalling :				
Automatic dial impulses. Frequencies to use	—	106	I bis	141

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Signalling (*continued*) :				
Carrier circuits	239	—	I bis	185
Frequency and Level	201	—	I bis	139
Frequencies. General schematic	202	—	III	86
International circuits	201	106	I bis	139
Level. Limits	201	—	I bis	139
Voice frequency in automatic telephone service	—	107	I bis	142
Singing :				
A. T. & T. Co.'s proposition in connection with minimum losses on two and four-wire circuits	40	—	I	57
Margin. Definition	171	—	I bis	60
„ Measurement	391	158	I bis	304
Point. Definition	171	—	I bis	59
	261	—	I bis	215
„ Measurement	388	—	IV	87
	391	—	IV	93
Sound :				
Articulation	182	—	I bis	81
Energy, density	60	—	I	88
Intensity	60	—	I	88
Masking effect	61	—	I	90
Meter	—	181	I bis	384
	183	—	I bis	83
„ Bibliography for	—	189	I bis	398
„ Summation of powers	—	186	I bis	394
„ Operating characteristics	—	184	I bis	391
	—	187	I bis	396
Maximum, pressure	59	—	I	87
Peak	59	—	I	87
Specifications :				
Cable sheaths	—	79	II bis	109
General remarks	319	—	I bis	255
Psophometer	—	35	II bis	19
	484	—	IV	252
Repeaters : Broadcast	265	—	I bis	223
„ Carrier	266	—	I bis	225
„ Joining different types of cable	264	136	I bis	221
„ Voice frequency, four-wire	263	136	I bis	218
„ „ „ two-wire	261	135	I bis	215
Voice frequency Ringing equipment	202	—	I bis	139
Valves	267	136	I bis	226
Specifications, Typical :				
Cable. Factory lengths	320	—	I bis	256
„ Crosstalk considerations	415	—	IV	134
	416	—	IV	136
Echo suppressors	334	—	I bis	285
Loading coils	324	146	I bis	265
Repeater. Power plant	334	150	I bis	286
„ Section of cable and constituent parts	320	—	I bis	256
„ „ „ loaded cable for International service	326	—	I bis	269
„ Station calling	—	150	I bis	287
„ Stations and constituent parts	332	—	I bis	282
Repeaters	333	—	I bis	284

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Specifications, Typical (*continued*):				
Terminations	333	150	I bis	284
Transformers. Balanced	365	—	IV	49
„ Line	332	—	I bis	282
Speech Power. (See also "Volume"):				
Definition	179	—	I bis	76
Instantaneous	61	—	I	91
Peak	61	—	I	91
Speed of Answer, Interval	554	—	V	26
Spelling of phrases for use on international circuits	595	—	V	93
Stability:				
Calculation	273	—	III	212
	280	—	III	224
Definition	171	—	I bis	60
Margin of	171	—	I bis	60
Measurement	391	158	I bis	60
	171	—	I bis	60
Overall	—	113	I bis	156
Open wire lines	270	—	III	207, 209
Picture Telegraphy	252	—	III	176
Two four-wire circuits interconnected	236	—	III	147
Statistics, Traffic:				
To be sent to C.C.I.F.	615	—	V	124
„ „ „ „ U.I.T.	617	—	V	127
Stiffness, Acoustic	63	—	I	93
Stock Exchange Installations:				
Direct Junction circuits	256	—	III	182
„ Trunk circuits	255	—	III	181
General conditions	255	—	III	181
Signalling	255	—	III	181
Special operators at Public Exchanges	256	—	III	182
Strache's gasoscope	68	—	I	102
Structure, Constant Resistance	67	—	I	100
Subscribers:				
Apparatus. Conditions of connection to leased International circuits	253	—	III	177, 178
Apparatus. Measurement	253	—	III	177
	428	—	IV	157
„ Overloading International circuits	254	—	III	178
Defaulting	614	—	V	122
Installations. Measurements from Exchange	448	—	IV	194
„ Recommendations	253	—	III	177
Lines and Instruments	—	128	I bis	200
List	568	—	V	49
Submarine Cables. (See "Cables, Submarine.")				
Switching Arrangements:				
European. Principles	184	82	I bis	84
France	220	—	III	177
Germany	206	—	III	92
Great Britain	210	—	III	100
Netherlands	224	—	III	126
U.S.A.	222	—	III	122

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Symbols	51	—	I	76
	183	—	III	45
Tariffs. (See "Rates.")				
Telecommunications Convention (Madrid 1932), Extract from Telephone Regulations	541	—	I bis	523
Telegraphy:				
Co-existence with Telephony. Recommendations	307	—	I bis	229
Frequencies. General Schematic	202	—	III	86
Separate circuits in Telephone cables	309	—	I bis	234
Telegraphy, Infra-Acoustic:				
Crosstalk	308	—	I bis	231
Earth unbalance	308	—	I bis	231
Frequency band	237	—	I bis	181
General rules	307	137	I bis	230
Impedance	307	—	I bis	230
Increase of Attenuation of Telephone circuit	307	—	I bis	230
Maximum E.M.F.	307	—	I bis	230
„ current	307	—	I bis	230
Noise	308	—	I bis	230
On circuits exposed to power lines	—	138	I bis	240
Propagation time	—	137	I bis	231
Psophometric E.M.F.	308	—	I bis	230
Telegraphy Picture:				
Attenuation distortion	251	—	III	175
Conditions of service and rates	610	—	V	116
Crosstalk and Noise	252	—	III	176
Echo Suppressors	251	—	III	174
Equivalent and level	251	—	III	174
Marking of circuits	252	—	III	176
Maximum power	251	—	III	175
Phase distortion	251	—	III	175
Simultaneous transmission	251	—	III	174
Stability	252	—	III	176
Subscribers' Installations	254	—	III	179
Telephone circuits	250	—	III	173
Two-wire circuits not admissible	250	—	III	174
Telegraph service between two telephone subscribers. (See "Telegraphy Telex.")				
Telegraphy, Sub-audio. (See "Infra-acoustic.")				
Telegraphy, Super-audio. (See "Ultra-acoustic.")				
Telegraphy, Superposed circuits:				
Crosstalk	309	—	I bis	234
General rules	309	—	I bis	234
Telegraphy, TELEX:				
Crosstalk	—	138	I bis	236
Frequency	—	138	I bis	236
General principles	—	138	I bis	236
Hangover time of Echo-suppressors	—	138	I bis	237
Power	—	138	I bis	236
Voice Frequency Ringing equipment. Modification	—	138	I bis	236
	—	143	I bis	247

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Telegraphy, Ultra-Acoustic :				
Circuits Maintenance	—	192	I bis	430
Echo suppressors, by-passing	—	137	I bis	233, 234
Frequency band	237	—	I bis	181
Frequencies to use	309	137	I bis	233
General rules	308	137	I bis	232
Impedance	308	—	I bis	232
Increase of Attenuation of Telephone circuit	308	—	I bis	232
Maximum power	308	—	I bis	232
Noise	308	—	I bis	232
Psophometric E.M.F.	308	—	I bis	233
Volume limiters	—	137	I bis	233
Telegraphy, Voice frequency :				
Battery variation	312	—	I bis	245
Circuits for, General conditions	311	142	I bis	244
„ „ Marking	311	—	I bis	245
„ „ Maintenance	524	—	I bis	430
Equivalent	311	—	I bis	246
General rules	311	142	I bis	234
Level, frontier station	311	—	I bis	247
Loading	311	—	I bis	244
Maximum power	309	—	I bis	234
Overall Equivalent	311	—	I bis	245
Reserve circuits	312	—	I bis	245
Two-wire circuits	311	—	I bis	244
Four-wire circuits	311	142	I bis	244
Telephone Conversations :				
Systems of recording	—	128	I bis	200
Telephone exchanges :				
Recommendations concerning	254, 256	—	III	180, 183
Telephone form factor, of voltage	—	31	II bis	12
	—	33	II bis	16
Telephone facilities, available to the public	572	—	V	56
Telephonometric tests :				
General remarks	433	—	IV	167
Normal volume	354	151	I bis	289
Precautions	441	—	I bis	306
Reference room noise	—	154	I bis	292
Telephony :				
Co-ordination with Radio Telephony	—	143	I bis	249
	313	—	III	277
International. Detailed arrangements for establishing ...	562	—	V	40
„ Extension	561	—	V	39
Two Band. (See " Carrier.")				
Telephotography. (See " Telegraphy, Picture.")				
Temperature :				
Correction	247	—	I bis	193
	204	—	III	87
	270	—	III	208
Terminations :				
Specification	333	—	I bis	284
Testing Apparatus :				
Artificial Mouth and Ear	—	164	I bis	346
	499	—	IV	295

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Testing Apparatus (*continued*) :				
Carrier circuit	239	—	I bis	184
Crosstalk	482	—	IV	250
Gain	481	—	IV	248
Impedance	481	—	IV	249
„ Unbalance (with reference to earth)	488	—	IV	260
Impulse Meter	—	164	I bis	344
Insulation	477	—	IV	241
Level Measuring Set	478	—	IV	243
Low Frequency	477	—	IV	241
Noise. (See " Psophometer.")				
Peak indicator	491	—	I bis	345
Power supply	483	—	IV	251
Resistance	477	—	IV	242
Sound Meter	—	181	I bis	384
Transmission Measuring Sets	478	—	IV	243
„ „ „ Oscillators	478	—	IV	243
„ „ „ Recording (Hypsograph)	480	—	IV	246
Valve	483	—	IV	251
Volume Indicator	490	—	I bis	342
„ „ Comparison with SFERT	491	—	I bis	345
„ Meters	490	—	I bis	342
Testing Apparatus, High Frequency :				
Filter	507	—	IV	310
Heterodyne Receiver	507	—	IV	310
Level Measuring Set	508	—	IV	310
Noise Meter	508	—	IV	311
Oscillator	507	—	IV	309
Transmission Measuring Sets	508	—	IV	310
Wheatstone Bridge	508	—	IV	311
Tests :				
Alternating Current	370	—	IV	57
Dielectric Strength	—	148	I bis	278
Frequency to be used	529	—	I bis	438
	203	—	III	85
Methods	370	—	IV	57
Subscribers' Instruments, in Service	—	174	I bis	370
Telephone circuits	379	—	IV	73
Testing Points on open wire International circuits	272	—	III	210
Threshold of Audibility	60	—	I	89
„ „ Feeling	60	—	I	90
Time :				
Chargeable. (See " Chargeable Time.")				
Conversation	554	—	V	27
Holding	554	—	V	28
Hourly paid, ratio	555	—	V	29
Maximum waiting. Ordinary and International calls	555	—	V	30
Operating	555	—	V	28
Toll Switching plans. (See " Switching Arrangements.")				
Traction networks :				
Direct current. Calculation of psophometric E.M.F. caused by current fluctuations	—	39	II bis	27

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Traction networks (*continued*) :				
Protective methods	—	61	II bis	77
Tramway. Return current	—	66	II bis	88
Traffic :				
Average working day	552	—	V	22
Circuits required. Determination of	623	—	V	135
„ „ Forecast of	623	—	V	136
International, decentralization	555	—	V	29
Light, agreed hours. Standardization	613	—	V	120
Statistics	615	—	V	124
Supervision of international telephone	620	—	V	121
Transducer :				
All pass	67	—	I	100
Dissymmetrical and Symmetrical	66	—	I	99
Loss or Gain	64	—	I	96
	169	—	I bis	57
Passive	66	—	I	99
Selective	67	—	I	100
Transfer constant	65	—	I	97
	167	—	I bis	54
Transferred charges for calls	582	233	I bis	559
Transformers :				
Balance. Specification for working standards	365	—	IV	49
Line. Specification	232	—	I bis	282
Tests	377	—	IV	70
Transient. (See " Distortion, Phase.")				
„ Phenomena	—	106	I bis	138
	—	113	I bis	157
Transit :				
Countries. Guaranteed minimum traffic	602	—	V	104
International centres	555	—	V	29
Traffic, operating rules	593	—	I bis	564
Transmission :				
Complex waves	179	—	I bis	76
Effective. Equivalent. (See " Equivalent, Effective Transmission.")				
Impairment	—	85	I bis	91
	182	—	I bis	82
Measuring Set. (See " Measuring Set.")				
Picture. (See " Telegraphy Picture.")				
Sinusoidal waves in steady state	178	—	I bis	75
Standards of	—	151	I bis	289
	344	—	IV	11
Systems. Broadcast Transmission	244	—	III	160
„ Carrier current	236	124	I bis	180
„ Definition	180	—	I bis	78
„ General rules	226	—	I bis	144
„ Ordinary Telephony	226	—	I bis	144
„ Picture Telegraphy	250	—	III	173
Telephone. Definitions	165	—	I bis	49
„ General principles	184	—	I bis	84
„ Index to Recommendations	—	318	1936 Index	7
Transmitter :				
Efficiency. Measurement	428	—	IV	157

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Transmitter (*continued*) :				
Harmonic Distortion. Measurement	431	—	IV	164
Microphone. Definition	66	—	I	98
Non-linear distortion. (See " Distortion.")				
Transmitting and Receiver Systems :				
Relative Efficiency	178	—	I bis	74
Transpositions :				
Definitions	177	—	I bis	73
Power line. Effect of	—	42	II bis	32
Trunk :				
Exchanges	256	—	III	183
Offering. Provision	258	—	III	185
Tube Vacuum. (See " Valve.")				
Unbalance :				
Capacity. (See " Capacity Unbalance.")				
Definitions	175	—	I bis	68
Distributed, of a telephone line with respect to earth. Noise ratio (Coefficient of Sensitivity)	—	40	II bis	28
Impedance, with reference to earth	—	40	II bis	28
Localised, with reference to earth. Measurement	—	40	II bis	28
	421	—	IV	144
	488	—	IV	260
Resultant to Power Lines	423	—	IV	147
Sheath	177	—	I bis	73
To Earth	175	—	I bis	68
United States of America. Toll Switching Plan	222	—	III	122
Urban Lines and Exchanges	254	—	III	180
Vacuum Tube. (See " Valve.")				
Valve :				
Broadcast repeaters on open wire lines. Maximum power ...	244	—	III	161
	245	—	III	162
Output. Maximum	—	110	I bis	152
	235	—	I bis	163
Noise	173	—	I bis	64
Specifications. Proposals	267	—	I bis	226
Tests	396	158	I bis	305
Via Terminals (conventional)	198	—	III	78
Vibration :				
Free and forced	63	—	I	94
Vocabulary :				
Acoustic	58	—	I	85
International Telephone. Publication of second edition ...	18	—	I	32
Voice Frequency Telegraphy. (See " Telegraphy V.F.")				
,, ,, Telephony. (See " Telephony.")				
Voltage :				
Disturbing of rectifiers. Reduction of	—	41	II bis	30
Equivalent disturbing. Objective measurement of	—	39	II bis	25
,, ,, voltage. Definition	—	31	II bis	13
	—	34	II bis	17

	Page No. English Edition		French Text	
	1934	1936	Vol.	Page No.
Voltage (*continued*) :				
Microphone terminals	179	—	I bis	76
Psophometric	—	31	II bis	12
	—	33	II bis	16
Volume :				
Broadcast Transmission. Limits	247	126	I bis	191
	249	—	I bis	195
Definition	178	—	I bis	75
Indicator	180	—	I bis	77
	490	—	IV	263
,, Calibration	354	—	I bis	289
Measurement	433	—	IV	167
,, Types of Apparatus	180	—	I bis	77
Meter	490	—	IV	263
,, Calibration	433	—	IV	167
Normal, for voice-ear tests	354	151	I bis	289
Regulators, Automatic	—	143	I bis	249
Waiting times, equalizing in both directions	588	—	V	82
Weighting table (psophometer)	—	36	II bis	20
	485	—	IV	253
Working Standards. (See " Reference System.")				
Zone :				
Terminal Traffic	227	—	I bis	145