JOURNAL OF
The British Institution of Radio Engineers

(FOUNDED IN 1925 - INCORPORATED IN 1932)

" To promote the general advancement of and to facilitate the exchange of information and ideas on Radio Science."

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23rd ANNUAL REPORT OF THE COUNCIL OF THE INSTITUTION

The Council has pleasure in submitting the following report of the Institution's activities for the twelve months ended 31st March, 1949. The Annual General Meeting will be held at the London School of Hygiene & Tropical Medicine, Gower Street, London, W.C.1, on Thursday, September 22nd, 1949.*

INTRODUCTION

Compared with pre-war conditions the scope of the radio engineer's activities has altered considerably ; the variety of equipment now designed and produced creates new demands on the membership and it has, therefore, been necessary for the Council to review the Institution's work and ensure that its activities are abreast of progress in the radio field.

Possibly the most important activity of any Institution is the encouragement and promotion of informed discussion ; in this respect there is considerable scope, for membership of the Institution is now spread over a wide field of radio application and embraces research, development and production. Whilst the Journal is the main medium for the dissemination of knowledge, meetings are the most profitable means of obtaining debate and intercourse between members. Much has still to be done in organizing such meetings, but during the year a total of 56 meetings were held by the seven main sections of the Institution.

Recruitment to the profession of suitably trained personnel is an essential pre-requisite for advancing still further the art of the radio engineer. This part of the Institution's work entails an understanding of the problems of both teacher and student ; the subject has been widely discussed in recent years and much goodwill has been shown by universities and technical colleges in response to many recommendations. Every opportunity must now be given to demonstrate the efficacy of post-war training.

Finally, the value of the Institution will always be largely judged by the strength and quality of its membership. The past year has been one of some difficulty and post-war adjustment for industry, and this has had some effect on membership development. In such circumstances, the continued increase in membership is a satisfactory reflection on the growing importance of the Institution.

Although much of the work of the Council may not show practical results immediately, considerable activity is indicated by the fact that the General Council and its Committees have had a total of 53 meetings during the year and at all of these there was a satisfactory attendance.

Over the past eight years the membership has approved the practice of the Annual Report being presented in sections which deal with the main activities of the Institution and this practice is continued.

**Members are reminded that notice of any other business must reach the Secretary 40 days before the meeting.*

PROFESSIONAL PURPOSES COMMITTEE

Problems of membership eligibility are constantly before any professional body and it is the Committee's duty to note the general policy of similar Institutions in regard to professional membership. Uniformity on the general qualifications required of any engineer is obviously desirable, but the different conditions which prevail in the various branches of engineering make such agreement difficult to achieve. The Institution is always prepared to enter into negotiations on this point.

There is already agreement on the basic requirements of registered studentship as laid down by the Engineering Joint Examinations Board, to which all the major engineering Institutions subscribe. A useful start has, therefore, been made in ensuring quality in the junior grade of professional membership, that of Studentship.

Those who watch the lists of new membership elections published in each issue of the Journal will have noticed that during the past three years there has been a very high proportion of Associates. This may be due in some measure to the gradually increasing requirement for election to the grade of Associate Member, but the Committee still feels that even the requirements for election to Associateship may be unnecessarily strict as compared with the requirements of other engineering bodies.

The last Annual General meeting approved the recommendation that the requirement for election to Associateship should be the same as Associate Membership except for the clause relating to passing the Graduateship Examination or exemption therefrom. The necessary change in the Articles will, therefore, be proposed at the Extraordinary General Meeting which is to be held in the near future and which will also deal with other suggested alterations in the constitution.

There are many who argue that membership of the Institution should not be closed to those who have achieved a degree of professional status solely by experience ; others contend that entry into any grade of membership should be controlled by examination as well as by experience. Some Institutions have found that a balance between experience and examination is provided by admitting to the class of Associate those who have the necessary experience qualifying for Associate Membership, but who have not had the necessary technical training and examination successes to qualify for direct election to Associate Membership. There is much to be said for both points of view ; neither presents an easy task for the Membership Committee who, even under the existing regulations of the Institution, often have difficulty in adjudicating fairly on a very wide range of applications which are submitted every month.

The work of the Membership Committee can be helped by the guidance of the Section Committees ; it is therefore proposed to institute procedure whereby a local Section Committee will first examine the proposal of any applicant in its area and submit a report to the Membership Committee together with the proposal.

It is also considered essential ,that *every member* of the Institution should have clearly in mind the qualifications necessary for the appropriate grades of membership. Greater care would then be taken in proposing new members, for obviously the best way to increase membership of the right kind is by personal recommendation. No proposal would be made or endorsed by the Local Section Committee unless the professional standing of the candidate was unquestionable *and* he possessed the right qualifications.

If these points are followed, the proposer and the Committee will avoid the embarrassment often caused by applications having to be refused.

The Professional Purposes Committee has also been concerned with examining the distribution of membership with a view to recommending the formation of additional Sections wherever there is a sufficient demand and active local membership. With the development of membership in the Sections, consideration has been given to the proposal that Section representation on the Council is better determined by the number of members in the Section.

Under the present constitution, the members of each Section are entitled to be represented on the Council by their Chairman. This does not of course give proportional representation and it is felt that representation might better be afforded by permitting the election to Council

of one corporate member for every one hundred (or any other number agreed) corporate members in each Section.

Progress has also been made in starting Graduates' and Students' Sections, which would, of course, be attached to the main Sections already in existence. It is hoped to commence the first of these Students Sections' during the 1949/50 session and the Scottish Section has been especially active in this matter.

An extension of the present Lease of 9 Bedford Square has been secured on terms which will justify the extensive repairs and decorations needed.

Finally, the Committee suggests that preparations should now be made to celebrate in fitting manner the Silver Jubilee of the Institution which will occur during 1950. It was originally proposed to hold an International Convention to mark the occasion ; as the Centenary of the Great Exhibition will be celebrated in 1951, however, it is felt that it will be in the best interests of everyone to delay the next Institution Convention until that year. Meanwhile, other arrangements are being considered to mark the Institution's 25th Anniversary.

MEMBERSHIP COMMITTEE

The Committee again reports a still further improvement in the quality of applications submitted, showing a far more general appreciation of the Institution's status. During the last ten years there have been many alterations in the regulations governing membership, all of which have progressively tended towards demanding higher standards of eligibility. This accounts to a large extent for the slight decrease in proposals received and accepted. As will be seen from the following tables, there has only been a net increase in the membership of 153, although a further strengthening of the Institution has resulted from younger members qualifying for advancement to the higher grades.

This figure is the lowest for the last seven years and is partly due to deaths but principally to removals from the active register of members. The resignations received from all the corporate grades and nearly all the non-corporate grades were caused by economic conditions. This is a circumstance over which the Institution has no control and it is probable that many of those members may in due time apply for reinstatement. The bulk of the Studentship resignations or expulsions were due to Students having completed the maximum period of five years without having entered for the Graduateship Examination.

In order to save the Committee's time it is still necessary (although not to such a large extent as in previous years) to advise many candidates of the unsuitability of their proposals and to suggest that they withdraw or amend them before reaching the Committee.

Reference has already been made to the increasing appreciation of the Institution and the above figures are incomplete without noting that during the year the Institution received a total of 1,432 enquiries regarding membership ; this is in addition to the very considerable amount of correspondence with intending applicants which is carried forward from year to year.

In this connection the Committee calls attention to the fact that the handling of such a large number of applications and transfers was only made possible by a great deal of hard work and assistance from Headquarters staff.

Year Book.—As promised in the last Annual Report, supplements to the 1948 Year Book have been published. These have been of very considerable assistance to the membership generally and to intending applicants who now have every facility, particularly in Great Britain, for obtaining the signatures of a proposer and seconder to forms of application. This, together with the points made by the Professional Purposes Committee on the assistance of Local Sections, considerably assists the Committee in their decisions.

Committee Personnel.—Since publication of the Year Book, Mr. N. C. Cordingly, O.B.E., has succeeded Mr. C. E. Bottle, M.B.E., as Chairman of the Committee.

Appointments Registers.—The Institution has continued to render service to all classes of members needing staff or requiring changes of appointments. Although there has been a slight decrease in the number of vacancies notified,

especially in the higher grades of appointment, the highest demand is still for junior engineers and for appointments overseas. Members are urged to co-operate by informing the Institution whenever they have secured new employment, whether through the Institution or not, and the senior members are especially invited to make use of the Appointment Registers in recruiting new staff.

Future Membership.—The Committee works closely with the Education Committee in an endeavour to ensure that new membership, with the correct standard of technical qualifications, is obtained. The Institution's need for strong membership could be met overnight if quality were sacrificed. This is not the intention of the Council but it must rely on the membership to put forward new members of the right quality.

1948/9

Direct Elections

Proposals	Members	Associate Members	Associates	Companions	Graduates	Students	Total
Received ..	11	63	34	2	14	290	414
Accepted ..	5	44	29*	1	26*	289	394

Transfers

Proposals	Associate Member to Member	Associate to Member	Associate to Associate Member	Associate to Companion	Graduate to Associate Member	Graduate to Associate	Student to Associate Member	Student to Associate	Student to Graduate	Total
Applied for ..	13	—	66	—	11	5	16	33	33	177
Accepted ..	8	—	49	—	5	5	6	23	44*	140

Reinstatements

Proposals	Members	Associate Members	Associates	Graduates	Students	Total
Applications received ..	—	4	5	1	3	13
Applications accepted ..	—	2	5	1	3	11

Removals due to Resignations, Expulsions or Deaths

Members	Associate Members	Associates	Graduates	Companions	Students	Total
5	27	38	—	1	177	248

**N.B. The above figures include applicants who have subsequently agreed to accept a lower grade of membership than that for which they originally applied.*

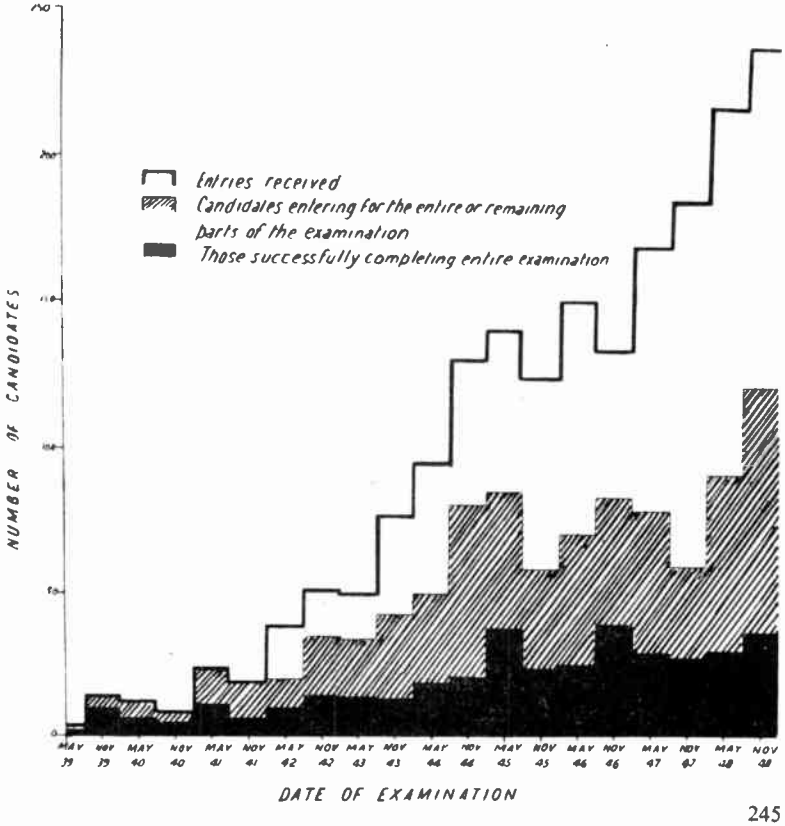
EDUCATION AND EXAMINATIONS COMMITTEE

Since March, 1948, the personnel of the Committee has been increased to ten by the additional appointments of Dr. W. J. Thomas, Mr. T. H. Pattinson and Flight-Lieutenant M. E. Claxton, B.Sc. (Associate Members). Mr. E. T. A. Rapson, M.Sc. (Member), has resigned and the Committee wishes to place on record its appreciation for his invaluable services since 1943, particularly his Chairmanship of the Committee from 1945-47.

For the last ten years the Graduateship Examination has regularly been held twice a year and the number of entries for each examination continues to increase rapidly, an indication of the growing status and prestige of the Institution. The number of entries is published in the Journal, together with the Pass Lists, and, as will be seen from the following histogram, the figures for 1948 show an increase of 32 per cent. on the previous year. The histogram also illustrates the relationship between entries received and the number of successful candidates for the last ten years from May, 1939, to November, 1948.

It must be remembered that in each examination a number of candidates whose entries have been accepted fail to present themselves for the examination. This is caused not only through illness, which accounts for only a small proportion, but is mainly due to overseas students who find they have not reached the required standard by the date of the examination. As full arrangements are made for these prospective candidates they have been included in the total number of entries. The histogram shows that 236 candidates entered for the November, 1948, examination. 49 of these did not attend.

The picture of radio training in Great Britain and the future membership of the Institution is



Histogram showing the number of entries received from candidates taking various parts, the final parts and the number of successful candidates completing the Graduateship Examination from May, 1939, to November, 1948. Note: Before May, 1942, candidates were required to enter for the entire examination at one sitting.

not complete, however, without also considering the alternative methods by which qualifications for membership may be obtained. The Education and Examinations Committee considers all cases for exemption which are not strictly in accordance with the exempting qualifications listed in the regulations. Any candidate who possesses those specified qualifications has his claim considered by the Membership Committee whilst the Education and Examinations Committee may consider special claims, e.g., training in universities or technical colleges not laid down in the regulations.

During the year the Committee considered 247 such claims, an increase of 55 per cent. over the previous year. It must be noted, however, that only 27 of these claims succeeded in gaining complete exemption but 204 obtained partial exemption.

Technical training committees of the industry and the teaching profession have, of course, an interest in these figures as well as in the availability of courses of technical training in radio engineering and all its ancillary branches. It is difficult to secure an overall figure from universities and technical colleges and the number of students who may be having private instruction. Apart from these methods of training, the only other reliable indication is from the number of people who enter for the recognized examinations and here it is of interest to note that 563 candidates entered for the City and Guilds of London Institute Radio Communications Grade 3* examination in 1948. Candidates who obtain from the City and Guilds a full Technological Certificate in Telecommunications qualify, of course, for complete exemption from the Institution's Graduateship Examination.

The Committee believes that the aforementioned facts are of considerable interest to the membership as a guide to the probable future membership of the Institution.

Examination Centres.—The Committee expresses gratitude to the many universities, technical colleges and education authorities for their co-operation in providing facilities for the May and November Graduateship Examinations. The examination was held at the normal ten centres in the British Isles and 20 centres throughout the world, including Port Elizabeth, Johannesburg, Penang, Singapore, Agra, Trichinopoly, Townsville and Sydney.

Revisions to Examination Syllabus.—The Committee has for some time been considering a major revision of the syllabus of the Graduateship Examination, in particular of the Physics of Part I and the inclusion of Mathematics as a compulsory subject. These two subjects are more than ever necessary to-day and without them a radio engineer cannot be considered to have a good foundation of fundamental knowledge.

It is probable that a three-hour paper in Mathematics will be included in the November, 1950, examination and will comprise both pure Mathematics and Mathematics applied to problems in radio and telecommunications.

The Education and Training of Radio Engineers.—Since 1944, the number of students receiving training in radio engineering has increased considerably and new examination schemes have been proposed by the various examination bodies. The Council feels that there is need for the collation of all the information on types and methods of training available and moreover, as stated elsewhere in this report, there is a great need for co-ordination in examination schemes. For this reason, a Committee has been appointed, under the Chairmanship of Professor H. M. Barlow (Member), to supplement the 1944 Post-war Report (Part 2) on Education and Training Facilities. In order that the report shall be impartial, representatives have been invited from all interested industrial, Government and other bodies. The recommendations of this Committee will be awaited with interest.

Outside Representation.—Through the Education Committee, the Institution continues to be represented on the City and Guilds of London Institute Advisory Committees on Radio Communication and Radio Service Work. Representatives of the Institution also served on a sub-committee of the Parliamentary and Scientific Committee which drafted a report on Technical Training and Education.

** A new Grade 4 examination was started in 1948 with a total entry of 110 candidates.*

Discussions with the Admiralty have taken place during the year and a meeting has been arranged with representatives of the Training and Technical Directorates of the Air Ministry. These meetings are promoted in order to obtain agreement on recognition accorded to membership of the Institution and to study the needs of the Services.

Radio Trades Examination Board.—In addition to being represented on the Board and its various Committees, the Institution continues to provide secretarial facilities.

The number of entries for the Radio Servicing Certificate Examination is rapidly increasing and a total of 91 candidates sat for the examination held in May, 1948. Of this number, 60 were successful in qualifying for the Certificate, 15 were referred in the Practical Examination and 15 failed to satisfy the examiners. One further candidate who was referred in the Practical Examination the previous year qualified for the Certificate.

The closing date for the May, 1949, examination was February 1st and 168 entries were received, of which 161 were accepted. These figures indicate the growing recognition of the need for such an examination and qualification which is especially welcomed by the manufacturers whose reputation depends on the service given by their radio and television receivers but which can be jeopardized by unskilled repair. For this reason, the constituent bodies of the Board, the Radio Industry Council, the Radio and Television Retailers' Association, the Scottish Radio and Retailers' Association, and the Institution maintain their support and subsidize the scheme.

The examination continues to be held in conjunction with the City and Guilds of London Institute and, during the past year, this body and the Board have also been engaged in final preparations for the syllabus and scheme of the Television Servicing Certificate Examination. The first examination will be held in 1950 and will comprise two written papers and a practical test.

Candidates for this examination will be required to possess the Board's Radio Servicing Certificate or the Certificate in Radio Service Work issued by the City and Guilds prior to 1947. This condition obviates the need for including fundamental radio theory and design practice in the Television Examination.

It is felt that this new qualification will receive the support and recognition already accorded to the Radio Servicing Certificate Examination and will be a further step towards the Board's object of providing an efficient and skilled service by qualified mechanics.

PROGRAMME AND PAPERS COMMITTEE

Since publication of the 1948 Year Book, Major N. Miers has retired from the Committee and has been replaced by Mr. R. G. Kitchenn, B.Sc. (Associate Member).

Reference has already been made in the introduction to this report to the number of meetings held ; in addition, the Committee reports that a meeting was held in Leeds in order to explore the possibility of forming a Section in Yorkshire. The response was not so great as had been anticipated, possibly due to a decrease in manufacturing activity in the area and for the time being no further action is being taken.

In addition to the papers presented at the meetings, the Committee has also had to examine a number of papers which were submitted as being only suitable for publication in the Journal, i.e., not suitable for verbal presentation. For either or both purposes, papers must be of a standard suitable for presentation to corporate members of the Institution and it is noteworthy that over 35 per cent. of the papers submitted had to be refused. The majority of the papers not accepted were submitted by non-members or non-corporate members and were unsuitable because they were either too elementary, fundamentally unsound, or the subject matter was already well known. These details should make it clear that the Committee does not refuse any contribution which may be of a controversial character provided that technical accuracy is observed and there is minimum repetition of matter already published.

The Committee still feels that with the wide field of activity covered by the membership there should be improvement in the range of papers so as to give greater balance in covering the whole field of radio and electronics. Members are, therefore, urged to make contributions to the

proceedings of the Institution and if in the first place a summary of the intended paper is submitted, the Committee will give every possible help to authors in ensuring that the final work meets with the Institution's requirements.

During the year, the papers presented at meetings and/or published in the Journal have covered general communication, broadcasting, radar, industrial electronics, television, instrumentation, design problems, physiological applications and components.

Acknowledgments.—Once again the Committee expresses its indebtedness to the following authorities for the help and facilities given to the Institution in holding meetings throughout the country :—

The London School of Hygiene and Tropical Medicine
Institution of Engineers and Shipbuilders in Scotland
Heriot Watt College, Edinburgh
Institution of Mining Engineers, Newcastle upon Tyne
Institution of Incorporated Accountants, Liverpool
Coventry Technical College
Manchester College of Technology

The technical press in general and the radio press in particular have again been most co-operative to the Institution by including notices and reports of meetings in their columns. Reports of the Institution's proceedings have also been given in many journals overseas.

The Journal.—Since the last Annual Report the Journal has been published monthly and members may not realise that this has only been made possible by the co-operation of the members and non-members who have contributed to these proceedings.

It must, therefore, be emphasized that the need for papers is as great as ever and that it is only fair to the membership as a whole that the burden should be distributed as widely as possible.

The proceedings should cover the widest interests of the Institution and should not be confined to a few well-harrowed lines. The Committee appreciates that even one short paper may embody the results of many years' work but it is felt that there must be many members who can make a useful contribution and who for one reason or another may not have taken the steps to have their work recorded.

The co-operation of each member is, therefore, solicited so as to enable the Committee to plan a varied and interesting programme not only for the next session of meetings but subsequently, and also for the third Convention, which the Council has now decided will definitely be held simultaneously with the Great Exhibition in 1951.

Lastly, the Committee reports that it continues to consider the need for a special Graduates and Students Journal ; the views of the Membership and Education Committees have been obtained and a report will be submitted to Council in the next few months.

Premiums.—Congratulations are due to the following members on their having been awarded Premiums for papers published during 1948 :—

The Heinrich Hertz Premium : To I. A. Harris (Associate Member) for his paper on *Calculation of Electrode Temperatures in the Radio Valve.*

The Marconi Premium : To F. C. F. Phillips for his paper on *A Direct Reading Frequency Measuring Set.*

Dr. Norman Partridge Memorial Award : To G. L. Hamburger (Member) for his paper on *An Automatic Audio Frequency Response Curve Tracer.*

The Clerk Maxwell Premium for 1948 has been withheld.

Council has considered establishing further Premiums covering most aspects of the Institution's work and an announcement of these additional Premiums will be made during the summer.

TECHNICAL COMMITTEE

The most important recommendation made by the Committee during the past 12 months and one on which the views of the membership are required, is the proposal to form technical groups, as distinct from the Sections of the Institution. Each main Section of the In-

stitution could form technical groups, subject to the approval of the Council, and membership of such groups would only be open to those members of the Institution interested in the specific work undertaken by each group.

The object of these technical groups would be to investigate and consider technical problems in the various specialized branches of radio engineering and to provide facilities for the discussion of these problems. This would be done by holding discussion meetings, arranging lectures and providing contributions to the Journal.

The Committee suggests that each group be controlled by a committee comprising a maximum of eight and a minimum of four members elected from and by the members of the group. The committee would appoint its own Chairman and Honorary Secretary and the scheme could be extended to form a national representative group committee to co-ordinate the work of the local group committees and exercise any supervision necessary in the general interests of the Institution.

Representation of the Institution.—As shown in the Year Book, the Institution is represented on a number of other technical bodies, principally the British Standards Institution. These invitations for Institution representation are welcomed and, whenever necessary, the Technical Committee examines the work in question so as to give the maximum assistance to its representatives and to the convening body.

The selection of representatives requires much care and the success which has attended the work of the B.S.I. is due to the way in which that organization has encouraged and invited representation on its various committees. It was, therefore, very disappointing to note the method employed by the Ministry of Works to obtain its draft Codes of Practice on Broadcast Reception and Sound Distribution Systems, to which reference was made in the last Annual Report. Although circulated by the British Standards Institution, the draft was prepared by a committee appointed by the main Codes of Practice Committee of the Ministry of Works. Other bodies made protests to the Institution on the failings of the draft, and, in consequence, representations were made to the Minister of Works regarding the absence of any invitation to the Institution to assist in the first drafting. Subsequently, Mr. P. Adorian and the Chairman of the Technical Committee had a meeting with the Director of the Codes of Practice Committee and an assurance has since been given that careful consideration will be given to the Institution's observations.

Wireless Telegraphy Bill.—The Institution, with other interested bodies, has, of course, been represented on the principal B.S.I. Committee dealing with the effect of spurious radiation on television reception and other experimental work. The Wireless Telegraphy Bill has, in general, been given the support of the Council of the Institution.

Finally, the Committee regrets that it has not been possible to publish the proposed report on "Electronic Aids to Industry." There have been very many books published on this subject and the Committee has been anxious to avoid repetition. During the course of the work, a most valuable bibliography has been built up for library reference and the Committee will be making a further report on this subject next year.

LIBRARY COMMITTEE

The Committee is pleased to report that since the foundation of the Louis Sterling Library Fund, the library has acquired for borrowing purposes over 1,000 volumes, and this opportunity is taken to thank those members who have donated books and periodicals. During the year the circulation of books, including bound periodicals, totalled 592, apart from a number of books not available in the library but obtained from outside sources for the use of members.

More members have used the library for the immediate consultation of volumes and current Journals ; in this connection members are urged to see that the librarian is notified of any books or periodicals borrowed. Unentered books are for the time being lost to the library and their loss causes other members great inconvenience and much trouble to the staff.

A regular feature in the Journal is the number of additions to the library and appreciations

have been received from members for the monthly Bulletin listing articles appearing in the Journals subscribed to by the library and which are considered to be of special interest to the membership.

The Committee takes this opportunity of thanking the publishers and reviewers for their very kind co-operation during the past year. By publishing reviews and notes of new books in the Journal, the attention of members is drawn to the new publications and considerable new material is acquired for the library, thus serving a two-fold purpose.

Bibliographies and abstracts on special subjects have been supplied to members on request and this service is shortly to be published in easy reference form so as to be freely available to the entire membership.

Science Abstracts.—The Technical Committee referred last year to the need for more general co-operation in the publication of abstracts of radio papers. The matter was referred to the Library Committee, and members will have no doubt observed that, in general, there has been considerable improvement in this connection. Moreover, Institution papers have been regularly featured in the better known Abstracts of this character.

PARLIAMENTARY COMMITTEE

The Committee has not had occasion to meet during the past twelve months, although the representatives have been present at a number of meetings of the Parliamentary and Scientific Committee. This latter body has had a very active year discussing the business of common interest both to scientific bodies and to members of the Houses of Parliament. The Institution's four representatives were particularly interested in the subjects of University and Technical Education, the Development of Inventions Act, the Supply and Production of Scientific Books, and the Wireless Telegraphy Bill, all of which were discussed during the Parliamentary sessions.

FINANCE COMMITTEE

The revenue of the Institution increased considerably as a result of changes in rates of subscriptions which became fully effective a year ago. The General Fund has also benefited from the sale of radio and other equipment bequeathed to the Institution by the late Wortley O. A. Baggally, who was elected a member of the Institution in 1933 and died in August 1947.

The comparative statement shows that all other sources of revenue are a little lower than in the preceding 12 months. This has been offset, however, by some saving in expenditure, notwithstanding the continued rise in prices which mainly affected the printing of the Proceedings. There has, of course, also been a substantial increase in Section meeting expenses as a result of the agreement to give greater autonomy to the Section Committees. This arrangement has, however, permitted improvement in the activities of the Local Sections to the benefit of the membership generally.

The net result of the year's finances has shown an excess of income over expenditure which, as will be seen from the Balance Sheet, now leaves only a very small debit on the Reserve Account. Otherwise, the Balance Sheet, which this year has been prepared in accordance with the requirements of the revised Act 1948, shows that there has been a further increase in the fixed assets of the Institution. Thus the Institution has improved its financial position during the year and the Committee is confident that during 1949 it will be possible to improve the services to members still further whilst still building up the financial position.

Apart from the Benevolent Fund, which is the subject of a special report, there are two other accounts, the Norman Partridge Memorial Fund and the President's Prize Fund, which are self-explanatory.

The Council proposes, however, to publish next year a separate account for the Building Fund. As stated elsewhere in this report, a fresh lease has been obtained on 9 Bedford Square ; during the first tenancy agreement the cost of improvements and decorations to the premises has had to be met mainly out of the General Fund. It will be recalled that the present Building Fund was inaugurated at the Annual General Meeting held in June, 1941 ; since then, donations have averaged £100 a year, thus giving a most useful total and relieving the General Fund at a time when that Fund had its greatest burdens. During 1949 alterations and improvements to the existing premises will cost several hundred pounds and this work is now under way.

The present building will, therefore, suit the Institution's requirements for the next few years but before the expiration of the renewed lease the Council is anxious to see if means can be found to enable the Institution to purchase its own premises. If accomplished, such a project will create a permanent asset of lasting benefit to the membership. Investment can then be safely made by the provision of many facilities, not the least of which should be the Institution's own lecture theatre ; whilst such an expense is not possible at the moment, it would not, in any case, be justified whilst renting premises.

Every endeavour will be made, therefore, to allocate each year from the General Fund a sum in favour of a fund to be renamed " Fund for the purchase and maintenance of an Institution Building." All donations received for the Building Fund will now be credited to the new Fund and it is hoped that many more members than hitherto will support this project. Without such support, the cost of an appropriate building would, at present, impose too great a burden on the General Fund.

The Staff.—Finally, the Council has had under consideration for some time a proposal to inaugurate a pension scheme for the staff of the Institution. The Committee is investigating the matter and hopes to make an arrangement equitable to the staff and within the financial ability of the Institution to support. If such a scheme is approved, the cost of future service benefits will be borne equally by the staff and the Institution. It is believed that this innovation will have the support of all members and will be welcomed by the staff, whose loyalty and devoted services the Council is pleased to acknowledge.

GENERAL

In publishing this report, the Council wishes to thank all members who have in any way rendered service to the Institution, especially those who have served on committees and thereby contributed to the achievements outlined in this Report. It is true that many problems before the Council and committees may not be readily apparent to the entire membership ; work which may only take a paragraph or two to report often involves a committee in many long meetings. The Council has always observed that such members aim at a result in the best interest of the membership and to the engineering profession. To those who have so willingly given their time to the Institution the membership is indeed grateful.

Next year the Institution will be celebrating the 25th Anniversary of its foundation. Its objects have remained constant in providing a forum for the discussion of radio problems and the means whereby engineers could best establish and maintain facilities for advancing the technique of their profession. Seven years after its foundation, the Institution secured Incorporation—the first step forward in obtaining official status. Among the members who prepared that first constitution are Mr. W. E. Miller, M.A.(Cantab.) (now a Vice-President) and Mr. L. H. Paddle, who is at present a member of the General Council and who has been nominated for election as a Vice-President during 1950.

The Institution has been particularly fortunate in its selection of officers and the Council is unanimous in recommending that Mr. Leslie H. Bedford, O.B.E., M.A., be re-elected President for the ensuing 12 months. In doing so, the Council takes this opportunity of thanking the President for his regular chairmanship of Council meetings and for his attendance at a number of Committee meetings.

Air Vice-Marshal R. S. Aitken, C.B., C.B.E., M.C., A.F.C., is retiring from the office of Vice-President, having served the Institution in that capacity since 1943. Members will recall that Air Vice-Marshal Aitken retired from the Royal Air Force soon after the cessation of hostilities, and the Council takes this opportunity of expressing appreciation for his many services to the Institution.

Other nominations for election to the Council are dealt with in the Agenda for the Annual General Meeting.

GENERAL ACCOUNT FOR THE YEAR ENDED 31st MARCH, 1949

EXPENDITURE

1947/8		£ s. d.	£ s. d.
£	To Examination Expenses including Printing of Papers, Examiners' and Invigilators' Fees and Incidental		
388	Expenses		467 10 7
	,, Printing and Publishing Journal, Reports, Regulations and Year Book,		
810	less Advertising Receipts		913 11 2
4,597	,, Salaries and State Insurance		4,790 1 0
563	,, Postage and Telephone		452 13 8
	,, Institution Premises :—		
670	Rent, Rates and Insurance ..	727 16 10	
133	Lighting and Heating	123 1 4	
201	Office Expenses and Cleaning ..	214 7 9	
			1065 5 11
497	,, Printing, Stationery and Certificates ..		385 6 9
687	,, Secretary's and Delegates' Expenses ..		599 4 1
544	,, Section Meeting Expenses		806 12 2
352	,, Convention Expenses		— — —
32	,, Audit and Accountancy Fees		42 0 0
54	,, Bank Charges and Cheque Books ..		97 8 0
243	,, Grants to Other Institutions		149 11 0
142	,, Sundry Expenses		182 8 5
12	,, Premiums and Awards		48 18 2
	,, Depreciation :—		
143	Office Furniture and Fittings ..	161 2 1	
46	Library	50 9 2	
			211 11 3
—	,, Excess of Income over Expenditure ..		401 4 1
£10,114			£10,613 6 3

INCOME

1947/8		£ s. d.
£		
5,856	By Subscriptions including Arrears	7,579 8 2
179	,, Compounded Subscriptions—Life Members ..	63 0 0
86	,, By Donations to Building Fund, less repairs during year	84 9 6
—	,, By Proceeds of Sale of Baggaly Bequest	243 15 0
700	,, Examination and Exemption Fees	696 16 6
527	,, Entrance and Transfer Fees	336 7 6
1,271	,, Sale of Examination Papers, Reprints and Journal	1,197 9 7
12	,, Interest on Investments (Gross)	12 0 0
	,, By Radio Trades Examination Board—Secretarial	
598	Charges and Expenses Incurred	400 0 0
885	,, Excess of Expenditure over Income	— — —
£10,114		£10,613 6 3

BALANCE SHEET AS AT 31st MARCH, 1949

£		£ s. d.	£ s. d.
	RESERVES		
500	*Library Reserve Account*		500 0 0
	Prize Fund :—		
	Balance 1st April, 1948	2 11 6	
	Less Awards during year	10 5 8	
3	*Deducted per Contra*	7 14 2	
	CURRENT LIABILITIES		
1,761	*Sundry Creditors*	1,335 5 3	
1,038	*Subscriptions and Examination Fees in Advance*	874 6 3	
1,630	*Bank Overdraft*	2,695 5 0	4,904 16 6
£4,932			£5,404 16 6

£	£		£ s. d.	£ s. d.
		FIXED ASSETS		
1,399		*Office Furniture and Fittings at Cost*	2,221 5 3	
608	1,291	*Less* Depreciation to date ..	769 5 3	1,452 0 0
613		*The Louis Sterling* Library at Cost	697 12 2	
193	420	*Less* Depreciation to date ..	243 12 2	454 0 0
	400	*Investments at Cost*—£400 3 per cent. Defence Bonds.. ..		400 0 0
	2,111			2,306 0 0
		CURRENT ASSETS		
	1,129	*Stock of Stationery, Journals and Examination Papers* at Cost..	1,842 14 1	
	1,082	*Sundry Debtors*, and payments in advance, including Subscriptions in arrear	1,002 10 2	
	—	*Prize Fund per Contra*	7 14 2	
	5	*Cash in Hand*	28 1 1	
	17	*Cash in Bank*, No. 3 account ..	31 5 8	2,912 5 2
		RESERVE ACCOUNT		
		Balance as at 1st April, 1948 ..	587 15 5	
	588	*Less* Excess of Income over Expenditure for Year to 31.3.1949	401 4 1	186 11 4
	£4,932			£5,404 16 6

We have obtained all the information and explanations which to the best of our knowledge and belief were necessary for the purposes of our audit. In our opinion, proper books of account have been kept by the Institution so far as appears from our examination of those books.

We have examined the above Balance Sheet and annexed Income and Expenditure Account which are in agreement with the books of account. In our opinion and to the best of our information and according to the explanations given to us the said accounts give the information required by the Companies Act, 1948, in the manner so required, and the Balance Sheet gives a true and fair view of the state of the Institution's affairs as at the 31st March, 1949, and the Income and Expenditure Account gives a true and fair view of the excess of income over expenditure for the year ended on that date.

26th April, 1949.

74 Victoria Street, Westminster, S.W.1.

Signed { J. L. THOMPSON (*Chairman of Council*)
S. R. CHAPMAN (*Treasurer*)
G. D. CLIFFORD (*General Secretary*) }

GLADSTONE, TITLEY & CO.,
Chartered Accountants.

THE PRESIDENT'S PRIZE FUND

INCOME ACCOUNT FOR THE YEAR ENDED 31st MARCH, 1949

£		£ s. d.	£		£ s. d.
2	To Award	1 15 6	5	By Interest Received (Gross)	7 10 0
3	,, Balance being Surplus for Year carried to Reserve Account	11 2 6	—	,, Income Tax Repayment 1946/7 and 1947/8 ..	5 8 0
£5		£12 18 0	£5		£12 18 0

BALANCE SHEET AS AT 31st MARCH, 1949

	LIABILITIES	£ s. d.	£ s. d.		*FIXED ASSETS*	£ s. d.	£ s. d.
£	*Reserve Account :—*			£	*Investments* at Cost :—		
242	*Balance* as at 1st April, 1948	244 12 5		200	£200 3 per cent. Savings Bonds ..	200 0 0	
3	*Add* Surplus for Year	11 2 6		50	£50 3 per cent. Defence Bonds ..	50 0 0	
245			255 14 11	£250			250 0 0
	Current Liabilities :—				*Current Assets :—*		
10	*Due to General Account*		1 15 1	5	*Due from Benevolent Fund*	4 16 0	
				—	*Income Tax Repayment Claim on Savings Bonds Interest*	2 14 0	
							7 10 0
£255			£257 10 0	£255			£257 10 0

DR. NORMAN PARTRIDGE MEMORIAL FUND

INCOME ACCOUNT FOR THE YEAR ENDED 31st MARCH, 1949

£		£ s. d.	£		£ s. d.
6	To Balance being Surplus for the Year carried to Reserve Account	6 0 0	6	By Interest Received (Gross)	6 0 0

BALANCE SHEET AS AT 31st MARCH, 1949

	LIABILITIES				*FIXED ASSETS*			
£	*Reserve Account* :—	£ s. d.	£ s. d.	£	*Investments at* Cost :—	£ s. d.	£ s. d.
207	*Balance* as at 1st April, 1948	213 6 5		200	£200 3 per cent. Defence Bonds ..		200 0 0
6	*Add* Surplus for Year	6 0 0			*Current Assets* :—		
213			219 6 5	6	*Due from Benevolent Fund*	12 0 0	
				7	*Cash at Bank*	7 6 5	
							19 6 5
£213			£219 6 5	£213			£219 6 5

We have audited the foregoing Balance Sheets dated 31st March, 1949, in respect of the President's Prize Fund, and Dr. Norman Partridge Memorial Fund. We have received all the information and explanations we have required and in our opinion the Balance Sheets represent the true and accurate state of the funds.

26th April, 1949.

74 Victoria Street, Westminster, S.W.1.

Signed { J. L. THOMPSON (*Chairman of Council*)
S. R. CHAPMAN (*Treasurer*) }

GLADSTONE TITLEY & CO.,
Chartered Accountants.

BENEVOLENT FUND

Annual Report of the Trustees for the period 1st April, 1948, to 31st March, 1949.

The Fund has now operated for 17 years, having been inaugurated in 1932. During that time, the support of members has been most encouraging and whilst it has not been possible until the last few years to put much aside for investment, the contributions of members have always enabled the Trustees to give some help to deserving cases.

Every effort is now being made to build up investments whilst giving, of course, first consideration to the claims made upon the Fund. Even so, it will be obvious that the Fund is limited to tiding members or their dependents over temporary difficulty ; much more could be done and it is hoped that there will be increasing support so as to enable the Trustees to give generous aid to any member meeting with misfortune.

Administration of the Fund is, of course, in accordance with the rules published in the 1948 Year Book, but the Trustees propose to call an Extraordinary General Meeting of voting-contributors in the near future in order to discuss the desirability of altering the rules so as to afford assistance to necessitous members in all grades of the Institution.

The Trustees wish to express their appreciation to all members and registered students who have contributed to the Fund during the past year. The total number of subscribers was 557 and the donations amounted to £503 3s. 3d.—a little under the previous year's record figure.

The Trustees desire particularly to refer members to the desirability of completing Deeds of Covenant whereby the Fund can make application to the Inland Revenue Authorities for repayment of the Income Tax paid by them upon the amount of their subscriptions, without involving the subscriber in any additional expenditure or financial obligation beyond their agreement to contribute to the Fund for a period of seven years. The completing of a Deed of Covenant thereby appreciably enhances the amount of contribution at no increased personal cost. The Secretary will gladly supply the necessary form upon application.

It is not possible to detail all the cases which have been referred to the Trustees, but the following are typical examples of the assistance given :—

1. An Associate unemployed through illness was given a grant towards the settlement of domestic expenses and the support of his wife and family.
2. An Associate unable to bring money into England from Czechoslovakia and unemployed through illness was given assistance.
3. An Associate Member died leaving a widow and young son. The member had been ill for several years with consequent irregular employment and an immediate grant was made to the widow for the settlement of heavy outstanding expenses. A subsequent weekly grant was made for a period of 10 weeks after which time the widow would be in receipt of an income.
4. A Member died suddenly, leaving a widow and two children. Assistance has been given to the widow in arranging for the education of the children.

The Trustees of the Fund especially desire to express thanks to the Management Committee of Reed's School for assistance and advice in dealing with the education of children of deceased members. Apart from their willingness to take such children into Reed's School, the officials have given much useful information and advice to the widows of such members.

It will be apparent that the Institution has many more claims on its Benevolent Fund than it can meet and the Trustees hope, therefore, that members will support this Fund to the best of their ability.

BENEVOLENT FUND

INCOME ACCOUNT FOR THE YEAR ENDED 31st MARCH, 1949

£		£ s. d.	£		£ s. d.
32	To Grants	65 10 0	504	By Subscriptions and Donations	503 3 3
508	„ Balance, being Surplus for Year carried to Reserve Account	478 17 6	36	„ Interest Received (Gross)	41 4 3
£540		£544 7 6	£540		£544 7 6

BALANCE SHEET AS AT 31st MARCH, 1949

LIABILITIES

£		£ s. d.	£ s. d.
	Reserve Account :—		
1,422	Balance as at 1st April, 1948	1,929 10 0	
508	*Add* Surplus for Year	478 17 6	
1930			2,408 7 6
	Current Liabilities :—		
5	*Due to President's Prize Fund*	4 16 0	
6	*Due to Dr. Norman Partridge Memorial Fund*	12 0 0	
			16 16 0
£1,941			£2,425 3 6

FIXED ASSETS

£		£ s. d.	£ s. d.
	Investments at Cost :—		
500	£1,200 2½ per cent. Defence Bonds ..	1,200 0 0	
900	£900 3 per cent. Defence Bonds ..	900 0 0	
100	£100 3 per cent. Savings Bonds ..	100 0 0	
104	£100 3½ per cent. War Loan ..	104 0 0	
1,604			2,304 0 0
	Current Assets :—		
298	*Due from General Account*	76 8 2	
39	*Cash at Bank*	44 15 4	
			121 3 6
£1,941			£2,425 3 6

I have audited the above written Balance Sheet dated 31st March, 1949, in respect of the Benevolent Fund. I have received all the information and explanations I have required and in my opinion the Balance Sheet represents the true and accurate state of the Benevolent Fund.

26th April, 1949.

74 Victoria Street, Westminster, S.W.1.

Signed { LOUIS STERLING, LESLIE McMICHAEL } *Trustees*
{ G. D. CLIFFORD (*Hon. Secretary*)

R. H. JENKINS, F.C.A.,
Honorary Auditor.

AMERICAN BROADCASTING*

by

John H. Battison† (*Member*)

A paper read before the London Section on March 11th, 1949.

In order to understand clearly a number of expressions and references which will be made during the course of this paper, it is necessary that a brief explanation be given of the general organization of broadcasting in the United States for the benefit of those who are not familiar with it.

Many people have asked what an Allocations Engineer does, so perhaps a short explanation is in order.

The four major networks and a few of the larger independent stations maintain large engineering staffs, some members of which deal with propagation and the allocation of frequencies. Whenever the question of a new station arises, or improvement of coverage of existing ones, or interference, the Allocations Engineer deals with it. He appears at Federal Communications Commission hearings with industry proposals for the use of the spectrum, and generally acts as a liaison between the industry and the Federal Communications Commission.

A.M.

The Federal Communications Commission has established four classes of A.M. stations. Class I Clear Channel stations are of two types : Class IA stations, which are not duplicated at night within the boundaries of the United States, nor within 650 miles of the borders of the United States, have an operating power of 50 kW, and a daytime service area protected to 100 μV/m. Class IB stations may have a power of 10 kW to 50 kW and are duplicated at night. The daytime protected contour is 100 μV/m, and at night the 500 μV/m contour. Class II stations are also Clear Channel, and may be from ·25 kW to 50 kW. This class of station, as well as those following, is protected to the 500 μV/m day contour, but at night a Class II station is protected to its 2,500 μV/m contour. Regional stations may be ·5 kW to 5 kW, and depending upon their night-time power are protected to either 2,500 μV/m or 4,000 μV/m. In the last category is the purely local station ; this may have a minimum power of 100 W and a maximum of 250 W. The night-time protected contour is 4,000 μV/m. On local channels, directional antenna operation is not permitted. Skywave service is considered to be provided normally by Class I stations only. Synchronized operation is not permitted except in one or two purely local areas, such as Boston, where WBZ, a 50 kW Class I station, has a 1 kW booster, WBZA, some miles away at Springfield.

Certain frequencies are allocated to each class of station and, generally speaking, operation of an inferior class of station is not permitted on the higher class channels. For the purpose of calculating interference, various ratios of groundwave to groundwave and groundwave to skywave are specified by the Federal Communications Commission, and no stations are licensed for operation with less than 40 kc/s separation if their 25 mV/m contours overlap. It is of interest to note that certain values of contour are specified as those normally protected. However, although a Class II station night limit is 2,500 μV/m, any new station to-day would probably have to accept interference to a much higher contour due to the large number of stations already operating.

A.M. Directional Arrays

Owing to the extremely large number of A.M. stations operating on the North American Continent, the use of directional antennæ has become almost essential for new stations. When it is realized that over 2,000 stations operate in an area of 3·5 million square miles, a large part of which is very sparsely populated forest and mountain areas, neither requiring nor being capable of supporting radio stations, it will be apparent how essential this form of antenna is. Figures 1 and 2 show the conditions on various channels.

The Copenhagen plan for Europe which is scheduled to come into effect on March 15th, 1950, makes more frequencies available for broadcasting purposes than are available to the United States, but considerably fewer stations are assigned under its terms. It is interesting to

* Manuscript Received February 1949.
U.D.C. No. 621.396.712(73).

† Allocations Engineer, American Broadcasting Company, New York.

Fig. 1.—Regional channel, 1380 kc/s, showing directional antenna patterns. Day..... Night———.

note how comparatively few assignments specify or allow for directional operation. However, offsetting this to a small extent is the fact that powers of 200 kW are not uncommon in Europe, whereas at present 50 kW is the maximum allowed in the United States.

In the United States directional antenna design has almost become a fine art, and literally thousands of different patterns have been filed with the Federal Communications Commission in the form of proposed operations. Figures 3 to 5 show some examples of the art of the consulting engineer in contriving patterns to do specific jobs.

Minimum antenna radiation efficiencies are prescribed by the Federal Communications Commission for the various classes of stations. These range from a required 150 mV/m at one mile for a local station, to 225 mV/m for a clear channel station, with a power of 1 kW in the antenna. The r.m.s. voltage produced by the power specified must equal or exceed these figures on a pro rata basis ; that is, the field at one mile must equal the minimum multiplied by the square root of the increase in power. Until recently arrays of four or more towers were not very common. However, as it becomes more and more difficult to fit new stations into the rather crowded A.M. spectrum, arrays of five and six

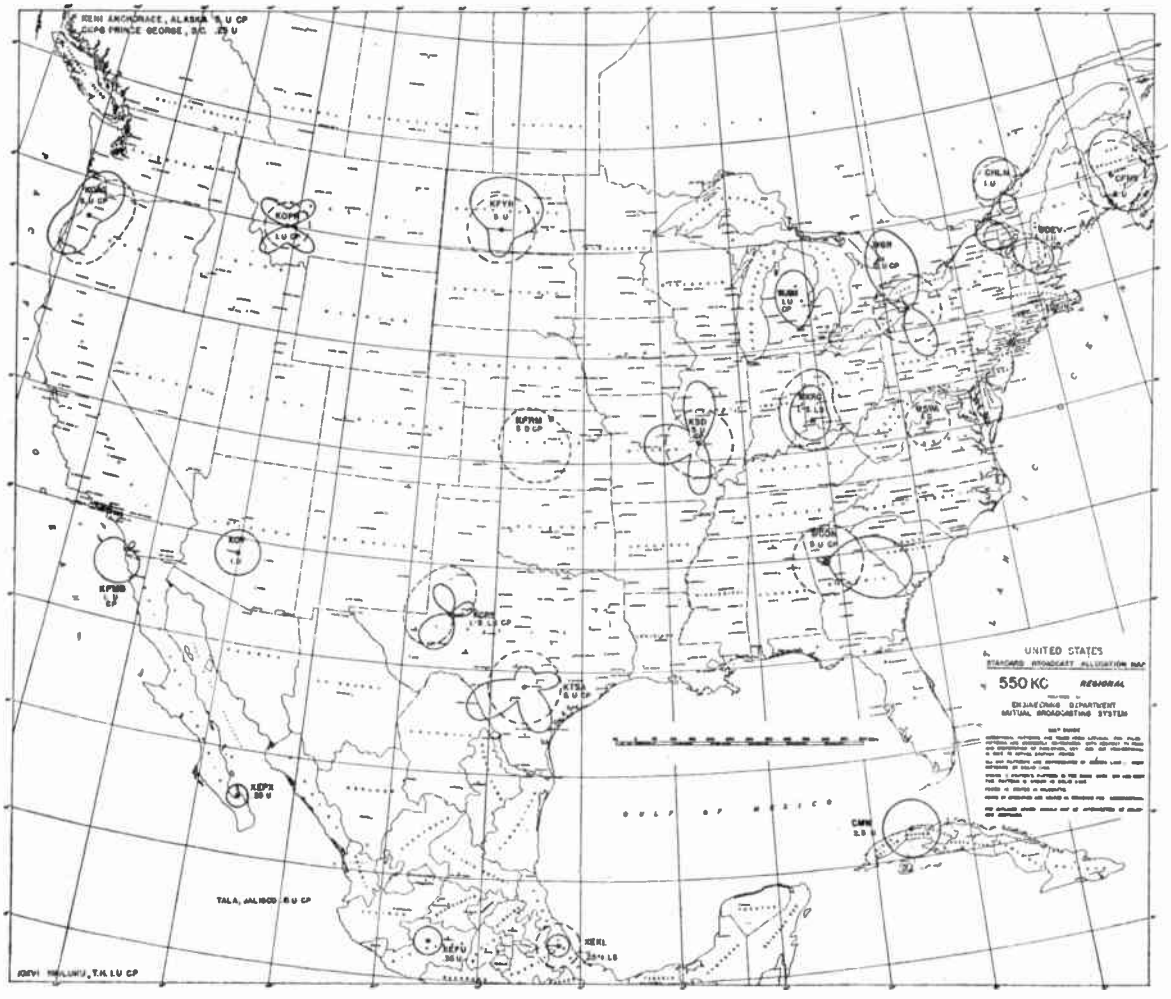


Fig. 2.—Regional channel, 550 kc/s, showing directional antenna patterns. Day..... Night———.

towers are coming into greater use. In this type of array great attention has to be paid to the effect of circulating currents; the consulting engineer, Mr. Glenn D. Gillett, recently published in *Proceedings of the I.R.E.* a very interesting analysis of this effect. In one installation a combination of very poor soil conductivity around the antenna site, and this circulating current effect, caused the field at one mile to be very much less than the minimum permitted under the F.C.C. standards. A top loading consisting of four equally spaced No. 8 copper wires running out to 12 ft. posts 175 ft. from the bases of the towers was erected. Using this most unusual top loading plus extra earthing screens and ground radials the radiation resistance was increased to a figure which gave the required radiation.

In the United States the number of broadcasting stations is limited only by the economics of the various areas and the space available in the spectrum. Consequently agreement was necessary between the nations of the American continent to prevent wasteful interference and frequency jumping. This common need resulted in the creation of the North American Regional Broadcasters' Agreement or, as it is usually called, "NARBA." All the North American

nations as well as Bermuda, Newfoundland and the Bahamas are signatories.

By this agreement frequencies are allocated to various countries, and standards are agreed upon, such as the use of channels and interference limits. Of course, in addition to the

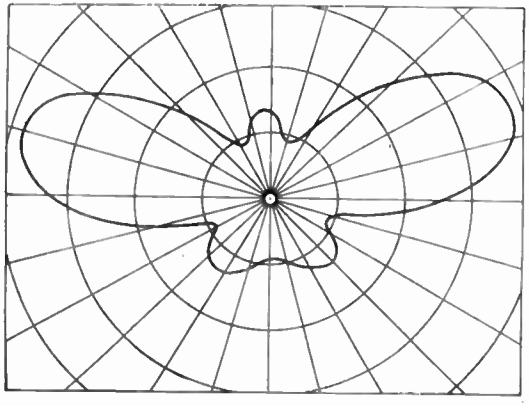


Fig. 3.—Directional antenna pattern.

NARBA rules individual members make their own—provided they do not conflict with NARBA. For instance, under NARBA certain frequencies are designated CLEAR CHANNELS, and a minimum power of 50 kW is set for them. The F.C.C. has ruled that no power in excess of 50 kW may be used in the U.S.

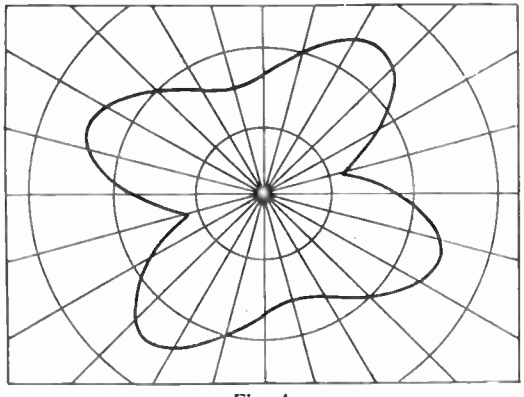


Fig. 4.

This anomaly has led to various suggestions for increasing the power of the U.S. clear channel stations. A plan which was presented at the last clear channel hearings called for 20 stations of 750 kW each. These would provide four network programme services to most of the country via primary and secondary service, and the regional and local stations would continue to serve local areas.

Methods of construction in general follow the same lines as those used in England and other countries. Of course, wherever possible, advantage is taken of natural conditions to improve coverage. When the American Broadcasting Company built a new 50 kW station in San Francisco in 1947, the three towers were located in the centre of a salt marsh ; in fact, the whole transmitter building was put on a man-made island. Included in its service area are approximately 2,500,000 people.

The system of operating used in the U.S. is intriguing and, later, when describing the operations of the American Broadcasting Company,

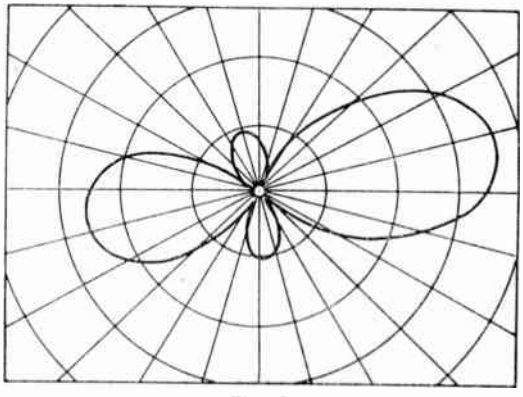


Fig. 5.

reference will be made to it. In this connection it may be of interest to mention the time difference between the east and west coasts. New York is three hours ahead of Los Angeles, and most of the main programmes originate in one of these two cities, with Chicago in third place. For programmes to be heard at the same clock time on both sides of the country it is necessary to record many programmes for later rebroadcast. The American Broadcasting Company uses Ampex tape recorders for this purpose. When summer time goes into effect the situation becomes really complicated. Some states use it, some do not. Even within the confines of one state times may vary, and it is not unusual for the majority of towns to be on summer time, with the remainder on standard time. This really causes confusion. Of course, that is not strictly speaking an engineering problem—it belongs to programme planning. However, it

serves to give an idea of the problems involved in serving a country as large as the United States.

Frequency Modulation

This is an infant branch of broadcasting which has had a somewhat disturbed life. It was first developed about 1935 for commercial use, and occupied a place in the low frequency band around 50 Mc/s. Then came the war and all activity stopped. After the war it got going again, and interest became very great. It was found necessary to move it to a higher frequency, and the band 88 to 108 Mc/s was chosen. There are already over 500 F.M. stations in the United States, with hundreds more under construction. Just as F.M. really began to get going at full speed, television came along and captured the public's imagination, so that interest in it has waned somewhat. However, it seems quite possible that the radio service of the future will consist of A.M. (high power), F.M. and television.

Frequency modulation assignments are made in the band from 88·1 Mc/s to 107·9 Mc/s. Each channel has a 200 kc/s bandwidth, therefore they occur at 88·1 Mc/s, 88·3 Mc/s and so on. The bandwidth allocated is 150 kc/s, i.e., a deviation of plus or minus 75 kc/s, which leaves a 25 kc/s guardband between channels. Metropolitan channels are allocated on the basis of 800 kc/s, or four channels separation. In the eastern part of the country the maximum power is 20 kW with a maximum height above average terrain of 500 ft. Of course, if the antenna height is decreased, the radiated power may be increased to provide the same effective coverage. The F.M. Standards require a minimum of 1 mV/m to be laid down over what is considered the primary service area with 50 μV/m regarded as the normal limit of service. 5 mV/m is the minimum acceptable for use in the city where the main studios are located.

It may be of interest to consider for a moment the method used to determine the antenna elevation above average terrain. Eight radials are drawn from the site on a topographical map : a graph is then drawn for each radial with distance in miles, and height in feet, as the horizontal and vertical ordinates respectively. The height of the ground for the distance from 2 to 10 miles from the transmitter is then averaged, either by a planimeter, or by taking a large number of equally spaced distances. This height is then considered to be the average elevation of the terrain out to 10 miles. When all eight radials have thus been calculated, the eight results are again averaged and the final figure is considered to be the average elevation of the terrain surrounding the transmitter. This is the method used by the Federal Communications Commission. Some engineers claim that a more accurate result is obtained by the " extended radial method " in which the same operation is performed for the whole distance required to be served.

Generally speaking, in the western part of the United States the F.C.C. has allowed F.M. powers in excess of the equivalent of 20 kW at 500 ft above average terrain. This latter effective radiated power usually results in the 1 mV/m contour falling about 31 miles from the transmitter, and the 50 μV/m contour about 50 miles away. In places where higher powers are allowed transmitters of 50 kW are employed with antenna gains of 8 or more, thus some stations have an E.R.P. of over 400 kW. This power from an antenna on a mountain top can extend the service area to over 100 miles.

The most popular type of antenna for F.M. is without doubt the R.C.A. " Pylon." It is simply a cylinder of height approximately one wavelength, and circumference about half a wavelength, with a narrow slot down one side. The drive is applied at the slot, the two edges of which form a parallel wire transmission line. Radiation then occurs from what is in effect an infinite series of current loops. There is no need for trick phasing stubs to feed this antenna and gains of 6 are easily obtained from four sections. Windloading and icing, which are quite a problem in this country, are not severe and icing can be controlled by de-icers. It is also fairly inconspicuous, which is a good point when it is going to be used in a residential district.

The Super Turnstile antenna is also quite popular, although used chiefly for television. Its broad bandwidth of about 15 Mc/s makes it very suitable for television, and particularly for diplexing and triplexing. The former is a system of feeding both video and audio signal into one antenna ; the latter includes an additional F.M. programme as well. This saves the use of two antennæ for television, and three if F.M. is also used. Triplexing is limited to low power operation, and if the F.M. frequency is very different from the television frequency a lower F.M. gain is realized.

Progress in antenna design has been very con-

siderable in the last few years. When radio first started the "TEE" or long wire antenna was the rule. Then came the first vertical broadcast antennæ which were considered quite radical. Nowadays we find that hardly any stations use anything else but vertical towers. After all, flat top antennæ would be rather complicated for directional arrays! So we find a picture like this at quite a lot of stations in the United States. There is an A.M. station with perhaps a three tower array; on one tower is a Pylon antenna for F.M., and above it a super turnstile antenna for television. Probably mounted lower down is a parabolic reflector for the 7000 Mc/s microwave television relay, and perhaps also an antenna for a studio link operating on 940 Mc/s to provide high fidelity F.M. link service for the F.M. station. That arrangement is not quite as common, however, as is the city layout where a television and F.M. station operate from the same site with one antenna above the other. It is the exception rather than the rule to find a broadcast station in the more populated parts of a town these days unless it has been there a long time, and people have built houses around it. Problems of blanket interference have made it necessary for the F.C.C. to lay down standards limiting the number of people within the 500 mV/m and 250 mV/m contours of an A.M. station. So far, no rules have been made concerning the high frequency stations, and since a high field strength is required in the built-up areas to be served it is usually necessary to locate within these particular areas. That will probably be one of the next problems to face in television.

Facsimile should also be mentioned here since it is receiving a considerable amount of attention from the public and broadcasters alike. Standards have been set up for both simplex and multiplex facsimile, or "Fax" as it is usually called. The simplex system requires that the F.M. programme be interrupted during the Fax transmission, whereas multiplex uses a sub-carrier to convey the modulation to the home recorder. The system appears to be quite reliable and should be extremely useful for supplying newspapers to outlying farmers, and districts without a daily newspaper. Probably some readers may remember the old Fultograph transmissions of the B.B.C. many years ago. This system is somewhat similar in appearance and operation but, of course, has better definition and is faster. The latest development is three-colour Fax which was demonstrated recently.

Before leaving the subject of F.M. it might be of interest to examine some of the standards set up for it. The gain factor of an antenna has been mentioned frequently in this paper but not the standard of reference; this is the ratio of the effective free space field intensity at one mile produced by the antenna to 137·8 mV/m (which is the field produced by a half-wave antenna in free space). Modulation of 100 per cent. is considered to be produced by a frequency swing of ± 75 kc/s with 15 kc/s as the highest frequency to be transmitted.

Television

As is probably already known, there is a "freeze" in the television allocations field at this moment, and no further applications are being granted. The present television bands cover the frequencies 54 Mc/s to 88 Mc/s, and 174 Mc/s to 216 Mc/s. These provide 12 channels, each 6 megacycles wide.

The allocation plan for television which was in use up to the time of the freeze allocated co-channel stations not less than 150 miles and adjacent channels not less than 75 miles apart. The limitation produced by these assignments varied considerably, and protection was not afforded to contours of less than 5 mV/m. This allocation plan did not take into account ionospheric interference. However, when this was considered, the interference was found to be higher in many cases. A new allocations plan is now under discussion, and there is a possibility that frequencies of 500 Mc/s and above will be used.

The normal effect of co-channel interference using unsynchronized carriers where interference is not sufficiently strong to develop a picture, consists of heavy black lines, called the "venetian blind effect." To aid in reducing co-channel interference a system of carrier synchronization has been proposed, and put into operation on a limited scale. At present, two stations, one in Washington and one in New York (distance approximately 200 miles) both operating on Channel 4, are trying this system. At a point about mid-way between the two stations, the frequency difference is compared and the difference converted to a control voltage. This control voltage is conveyed by land line to

one transmitter in the form of a 1,000-cycle tone, the phase of which depends upon the frequency difference. This controls the frequency of the oscillator, and provides synchronous operation.

Television Standards

Negative transmission Standards have been adopted, as opposed to the positive system used in Great Britain. The proponents of the negative system claim that its use results in less distortion of the received signal by interference than the latter system. The author has not had an opportunity to judge the two systems side by side. However, since black level corresponds to 75 per cent. peak carrier power, any interference will affect the receiver in the same way as an increase in carrier strength and result in driving the kinescope towards extinction. This causes the interference to show as a dark rather than a bright spot, and is, therefore, less noticeable. Proponents of the positive system declare that the characteristics of negative transmission render it more subject to sync. disturbance by interference : this seems to be a moot point.

Amplitude modulation is used for the video transmission, and frequency modulation for the sound. The latter presents no unusual problems since standard F.M. practice is followed. The swing for 100 per cent. modulation is +25 kc/s although it is recommended that the transmitter be capable of 40 kc/s deviation. Standard pre-emphasis is employed with a 75 microsecond time constant, and with a bandwidth of 50-15,000 cycles per second. The maximum distortion should not exceed 3·5 per cent. at 50 to 100 c/s, and the carrier noise level must be 50 db down or better.

The video modulation presents more problems however, since the bandwidth of 30 to 4,000,000 c/s renders the problem of obtaining reasonable anode impedances and stage gain somewhat difficult. Two methods are in use at present, the high-level and the low-level methods : R.C.A. uses the former and G.E. the latter. Low-level modulation necessitates high precision in tuning the intermediate circuits, since it is very easy by maladjustment to reinsert the sidebands already deliberately attenuated. On the other hand, high-level modulation requires a sideband filter, and some means of dissipating the unwanted power. The lower sideband is attenuated completely 1·25 Mc/s below the video carrier. Thus only the low and medium frequency lower sidebands are transmitted below the carrier while the higher frequencies are completely attenuated. The full sidebands are transmitted above the carrier, and in the receiver the 100 per cent. modulation is reinserted by tuning the receiver to the 50 per cent. voltage point of the receiver tuning curve.

5 kW is the maximum output generally available, although research is continuing into the question of production of higher power equipment. The use of antennæ with power gains of 7 and 8 is quite feasible on the higher frequencies due to the small size of the elements used. This often results in the attainment of the F.C.C.'s maximum limit of the equivalent of 50 kW radiated power at 500 ft. above average terrain. (The height above average terrain for television antennæ is calculated in the same way as for F.M.)

It should be noted that the power referred to above is *peak* power and not carrier power, that is, the peak power of the synchronizing pulses above black level. The average power of the carrier is about 60 per cent. of the peak, which is a little different from the expected figure of approximately 52 per cent. due to the fact that the sync. pulses must be added, and they raise the average to about 60 per cent. A total scan of 525 lines is used with interlacing, at the rate of 60 fields or 30 frames per second.

The normal black level is known as the "Pedestal" level and is 75 per cent. of the peak carrier or sync. values. White, of course, is indicated by the lower level of the wave form, and the transmitter output has a substantially inverse logarithmic relation to the brightness of the subject.

Stratovision

The system proposed by C. E. Nobles of Westinghouse, of relaying television from a high flying aircraft has been named "Stratovision." So far in these tests a B-29 has been used flying at heights up to 25,000 ft. A number of problems were encountered in getting sustained operation ; for example, although the (ambient) temperature at 25,000 ft. is 0°, the heat from the 5 kW television transmitter, plus a 1 kW F.M. transmitter, intercom. and associated equipment, was great enough to make life very uncomfortable for the crew, so an airconditioning unit was installed. This was large enough to cool a six-room house ! In Fig. 6, the antenna is shown extended below the aircraft in flight ; it is a simple turnstile type.

Normally it is carried in the bomb bay, Fig. 7, and extended by hydraulic pressure when in use. Incidentally, 68 h.p. are required to erect and hold it in place during flight.

Channel 6 (82-88 Mc/s) has been used for the standard television tests. Signals from ground

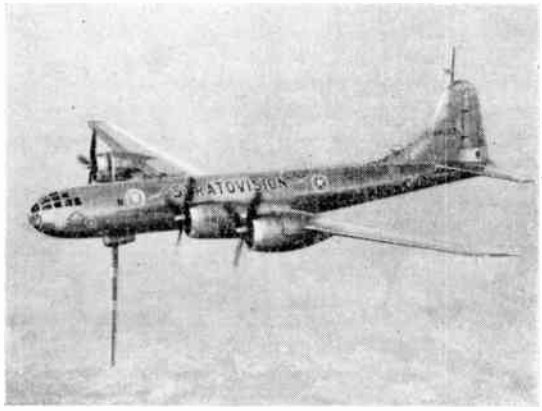


Fig. 6.—Stratovision B-29 in flight.

stations operating on Channel 2 were rebroadcast with considerable success. Sometimes, due to the extreme height of the receiving antenna, the desired signal was interfered with by other stations on the same channel; this resulted in the formation of the "venetian blind black bars effect" already mentioned. Of course, new

Fig. 7.—Turnstile antenna in bomb bay.

problems in interference and frequency allocations arise from this operation. The service area of a ground television station may be as much as 11,000-12,000 square miles, while that obtainable from an airborne station may easily be 200,000 square miles! This is a problem which is currently before the F.C.C. in the television allocating hearings.

As is to be expected, some old problems have been solved, while some new ones have arisen in connection with reception. Ghosts, i.e. multiple images, appear to have been virtually eliminated, at least in the usual forms. However, a new ghost has been found; that caused by bounce between the receiving antenna and the ground. This can be cured by placing the receiving antenna on, or very close to, the ground. In country places it would not seem to be a very serious matter, but for city dwellers it could pose a problem. However, since this system is really intended to provide service to the rural areas where at present there is not a very good service, this will probably not become a severe problem.

It is planned to carry a 9-man crew consisting of 3 aircrew and 6 operators, together with enough fuel for about 8 to 10 hours' flying. In actual operations a circular flight path of about four miles radius will be flown with a speed of about 180 m.p.h. with 10° bank. It is understood that the equipment is being modified, at

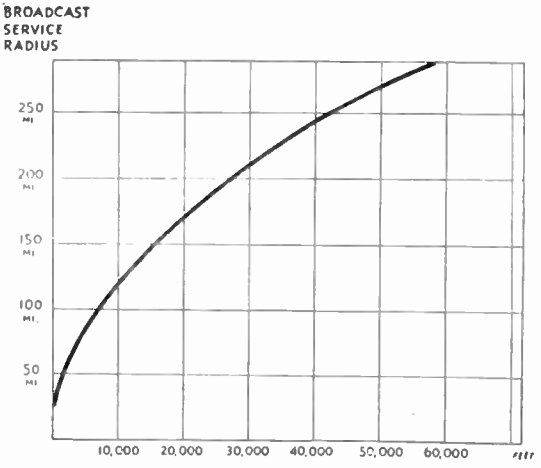


Fig. 8.

the time of writing, to take advantage of the experience gained in the tests already made.

Figure 8 is a chart of the relationship between antenna height and range. The basis of Stratovision becomes apparent from this. Figure 9 shows the average service area of a station in Pittsburgh as about 35 to 50 miles. Figure 10

shows the same station operating from a height of 30,000 ft over Pittsburgh. This extends the range to 200 miles, so that Baltimore and Washington and perhaps even Detroit would achieve reception. This is a 400-mile diameter

Fig. 9.—Service area of Television transmitter in Pittsburgh.

circle with an area of 103,000 square miles, and equal in area to New York plus Pennsylvania plus New Jersey states. This area would require 11 normal ground stations to cover it !

Programmes are transmitted to the plane by a

Fig. 10.—Service area of Stratovision transmitter over Pittsburgh.

vertical microwave transmitter. Transmission is by a parabolic antenna using about 7,000 Mc/s. In order to reduce the cost of operation, which is estimated at $1,000 per hour for actual flying time (not including ground facilities), more than one transmitter might be carried. This would eliminate the problem of erecting aerials for reception from a number of directions. Two aircraft would be in the air at a time at operational altitude in case of breakdown.

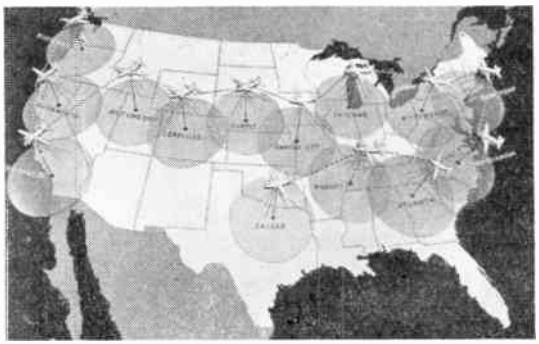


Fig. 11.—Cross-country microwave transmission by fourteen Stratovision planes.

One problem that has to be overcome is weather. However, above 20,000 ft it is nearly always calm, and by the use of modern navigational aids and alternative landing fields, 100 per cent. continuity is assured.

The subject of a cross-country coaxial cable has been raised : here is another way of doing it. Figure 11 shows how fourteen Stratovision planes could provide a nation-wide service. Located at

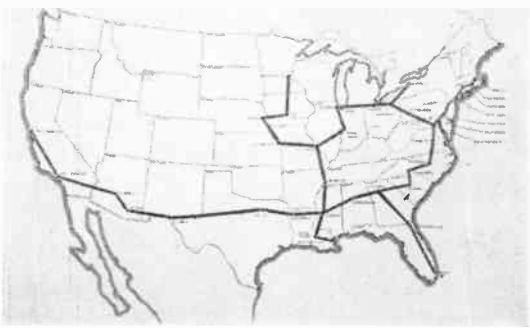


Fig. 12.—Coaxial cable route under construction.

New York, Pittsburgh, Chicago, Kansas City, western Wyoming, western Colorado, Salt Lake City and Los Angeles, these planes would not only transmit programmes across the country

but also to the areas below. Fourteen of these planes could cover 51 per cent. of the United States and 78 per cent. of the population.

Figure 12 gives a view of the coaxial cable circuit expected to be ready by 1952.

The first aircraft used was a PV2 : Fig. 13 shows the aircraft in flight. The antenna is a loop, on a 10-ft. pole.

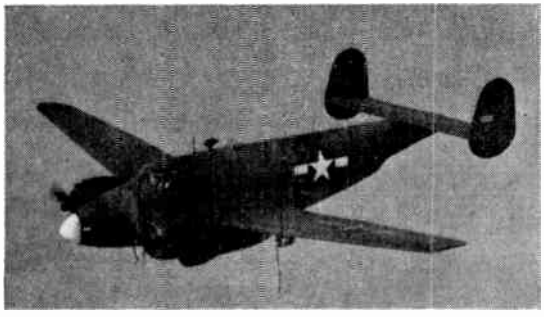


Fig. 13.—Experimental Stratovision transmission from a PV 2.

The scope of this paper is too broad to do more than touch briefly on the most interesting phases of American Radio. But before closing a brief outline of the operations of the American Broadcasting Company is presented in the hope that it may give readers an idea of how radio broadcasting networks operate in the United States.

The American Broadcasting Company has five A.M. stations, located in New York, Chicago, San Francisco, Detroit and Los Angeles. The first three are 50 kW stations, and the remainder operate with a power of 5 kW each. In each of these cities the company operates an F.M. station in connection with the A.M. operations. Five television stations are also operated, one in each of these five cities. These latter operate on Channel 7, i.e. 174-180 Mc/s, and are combined with the F.M. stations in all cities except New York where the F.M. station is located with the A.M. station. The company owns and operates all these stations.

Distributed over the rest of the country are 272 affiliates. These are individually owned private stations with powers ranging from 250 watts to 50,000 watts. These stations carry all or some of the programmes offered, depending on their individual plans. Some programmes are originated in New York, some in Los Angeles, some in Chicago and others in the studios of affiliates. The television networks operate in the same manner, except that, so far, St. Louis is the farthest west that the coaxial cable goes. New York is at present the centre of television operations. However, on the west coast, A.B.C. has acquired the Vitagraph movie production lot, and when that is ready for use, and the east-west coaxial line is completed, viewers anywhere across the country will be able to receive both New York and Hollywood programmes.

Acknowledgments

The author wishes to record with thanks permission received from the Mutual Broadcasting System to reproduce the Channel allocation maps in Fig. 1. He also wishes to thank the Westinghouse Company for permission to use the photographs and data on Stratovision.

A VALVE ASSISTED FILTER FOR AUDIO FREQUENCIES*

by

J. D. Storer (*Graduate*)

SUMMARY

The paper is divided into two main sections ; the first section describes the theoretical circuitry and principles of a type of valve assisted filter, which is claimed to be an improvement on the normal coil and condenser filter for certain applications.

Section two is concerned with the design of a frequency shift converter, incorporating the valve assisted type of filter, and it is intended as an example of an equipment redesigned to allow its incorporation.

Introduction

The wave filter is one of the most important items of circuitry in communications engineering; in various forms it is utilized throughout the whole frequency spectrum. If a particular portion of that spectrum is considered, that is the portion between 100 c/s and 100 Mc/s, it may be said that within this band there are to be found the majority of the frequencies utilized in radio and telecommunications.

From the point of view of wave-filtering, this spectrum may again be divided, the division being determined by whether crystal filters can or cannot be used. It is not common practice to include crystals in filters at frequencies below 60 kc/s, although they are occasionally employed at lower frequencies. Thus, we have the situation, that for frequencies above about 60 kc/s, it is possible to construct a reliable and reasonably cheap filter using crystals, but below this frequency the coil and condenser type are normally used ; this latter type being bulky and expensive to manufacture.

The need is therefore apparent for a wave filter of simple and inexpensive design, having a performance at low frequencies equal to that of a crystal filter at high frequencies.

With these facts in mind, a series of experiments were carried out in an endeavour to produce such a filter. The audio frequency spectrum below 10 kc/s was selected for the experiments, as it was considered uneconomical to use crystals at this frequency, and also a coil and condenser filter would involve considerable bulk and expense.

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As a result of these experiments it was found possible, by using an entirely new technique, to produce a valve assisted filter whose characteristics equalled those of a multi-section coil and condenser wave-filter, but which had certain other characteristics, such as that of voltage limiting, not normally associated with a filter. It is not therefore claimed that this particular type of valve assisted filter is capable of universally replacing the coil and condenser type, but it is claimed that the characteristics obtainable are nearer to those of an ideal filter, and equal to those obtainable by a normal filter of the most complex configuration. It is felt that the valve assisted filter has many applications in radio and telecommunications engineering, particularly in equipment containing a power supply.

This type of filter may be produced to meet the normal impedance loss-frequency requirements, but, in certain cases, by virtue of its difference in characteristics from a normal wave filter, it may be included in a circuit in a variety of ways. Section two describes a frequency shift adaptor incorporating the valve assisted type of filter, and two different designs are given to illustrate varied methods of utilizing the filter.

2. Technical Description

2.1. *General*

The valve assisted filter combines the function of voltage limiting and wave filtering : it is a development of the relaxation oscillator, and may best be described as a flip-flop oscillator which is inoperative until triggered by a sinusoidal input voltage, whose frequency when triggered is controlled by that of the triggering voltage, and which ceases to oscillate on the removal of the triggering voltage.

The triggering voltage is developed across a reactive component, and thus the instant at which controlled oscillation commences and ceases becomes a function of applied frequency.

The output of the relaxation oscillator consists of D.C. pulses, which may be integrated and converted into sine waves over the required band by a reactive output circuit.

2.2. *Basic Circuit*

Figure 1*a* shows a schematic diagram of the basic filter, from which the final circuit was developed. In this original filter a double triode valve having a high slope and a short grid base was employed, and the two tuned circuits were selected to resonate at a frequency *f*, having $\omega L = \omega C = 5{,}000\ \Omega$ at this frequency. A sinusoidal input of variable frequency was applied from a high impedance source.

The stable condition of the circuit with no input applied is as follows : a positive D.C. potential is applied via R_4 to the grid of V_1b causing this valve to conduct, its anode voltage is therefore low and the cathode current flowing through R_3 develops a bias voltage, V*b*, which is sufficient to back off V_1a beyond cut off point, V*c*. Figure 1*b*.

A sinusoidal input of frequency *f* is now applied across $L_1C_1R_1$, to the grid of V_1a. As this valve is biassed beyond cut-off point by the voltage V*b*, it will not conduct until the positive peaks of the input voltage V_1 exceeds $Vb - Vc$. When the input level is sufficient to fulfil this condition, a negative going voltage pulse will be produced in the anode circuit of V_1a during each positive half cycle of input volts ; the negative half cycle will merely tend to drive the valve further beyond cut-off and no current will flow. The width of the negative voltage pulse produced

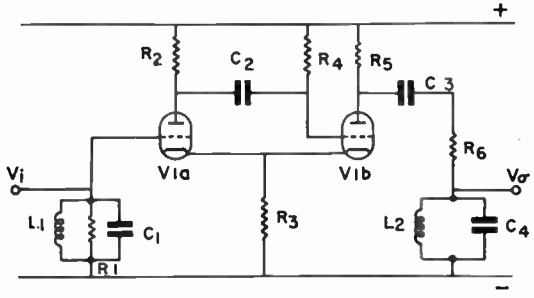

Fig. 1*a*.

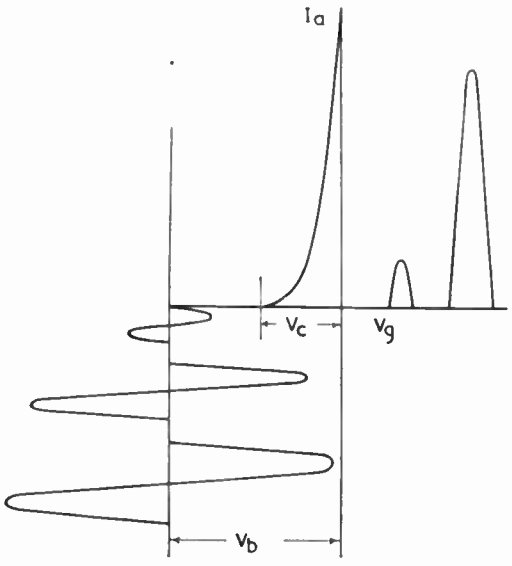

Fig. 1*b*.

will be very nearly equal to that of half the period of the input sine wave, and will occur in a slightly lagging phase relative to the input due to the time required for the sinusoidal wave form to build up to a level sufficient to overcome the backing off voltage.

This negative voltage is applied via the condenser C_2 to the grid of V_1b, and this sudden drop in potential cuts off V_1b, causing the anode volts to rise. At the instant of cut off, the backing off voltage across R_3 will fall to zero, and V_1a will conduct more readily. On the removal of the negative voltage from C_2 the grid of V_1b will return to its stable condition almost instantaneously, by virtue of the fact that the time constant of $R_2C_2R_4$ is kept exceedingly small.

As shown in figures 1*b* and 1*c*, due to the slope of the characteristic curve of V_1a, it is possible for a condition to arise when the positive peaks of input voltage only just exceed $Vb - Vc$, and the negative voltage pulse applied to C_2 is insufficient to cut off V_1b. As a result the condenser C_2 is only partly charged, the second, third, or some multiple of ensuing pulses at this level will eventually complete the charging process and V_1b will be cut off. In this case, however, the oscillation is not directly controlled by the input frequency, and the output of positive-going

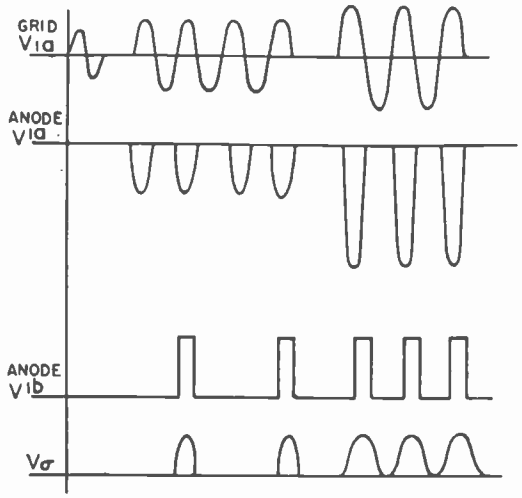

Fig. 1*c*.

square waves developed across R_5, need not bear any relationship to that frequency.

It was found that in practice this condition of uncontrolled oscillation occurred over an input voltage range of approximately 0·1 V; the consequence of this oscillation will be shown in the ensuing paragraphs. The positive-going output square waves are fed via C_3, which blocks the D.C. and restores a mean zero point to the waveform, and R_6 to the second resonant circuit comprising L_2C_4. The constants of the resonant circuit restore the square waves to an almost sinusoidal shape over a frequency range extending *n* cycles on either side of *f*, where *n* increases in direct relation to *f*, Fig. 1*c*.

2.3. *Filter Action*

So far, the input voltage to the circuit has been of constant frequency, equal to the resonant frequency of the two tuned circuits, and it has been shown that, provided the positive peaks of input voltage are of sufficient magnitude, the circuit will oscillate at the input frequency, and an output of a similar frequency but of slightly lagging phase will result. Thus, if the level of the input voltage is made to depend on the frequency of that input, a filter characteristic will result. This is obtained by shunting the input circuit of V_1a with the tuned circuit L_1C_1 which is damped by R_1 and has a voltage/frequency characteristic as shown in Fig. 1*d*. An output will only be obtained over a frequency range for which the voltage across the tuned circuit is of greater magnitude than the triggering level, and an output characteristic as shown in Fig. 1*d* will be obtained.

It has been pointed out earlier that the circuit will tend to oscillate at an arbitrary and uncontrolled frequency at certain levels of input voltage, this critical voltage will be reached over a range of input frequency dependant on the slope of the tuned circuit resonant curve, and the resultant effect will be a threshold zone during which uncontrolled oscillation occurs, at each end of the pass band of the filter.

The width of the pass band of the filter will depend on the voltage/frequency curve of the input tuned circuit, Fig. 1*d*, and it will be noted that it is possible to obtain a very narrow band width, of the order of ten cycles, if the resonant circuit has a high Q and is not heavily damped. It is, however, somewhat more difficult to produce a wide band-width at low frequencies, for instance with a mid band frequency of 2 kc/s a band-width greater than 1kc/s is not easily obtainable, although if the mid band frequency is increased to 8 kc/s a band-width of 4 kc/s is readily attainable. The increased band-width is obtained by damping the input tuned circuit, and this reduction in the slope of the curve will mean that the threshold effect on either side of the pass band will be increased. There are many applications of this type of filter in which the threshold effect is of no importance, but the characteristic is in general undesirable, and the basic circuit was elaborated to obviate this defect.

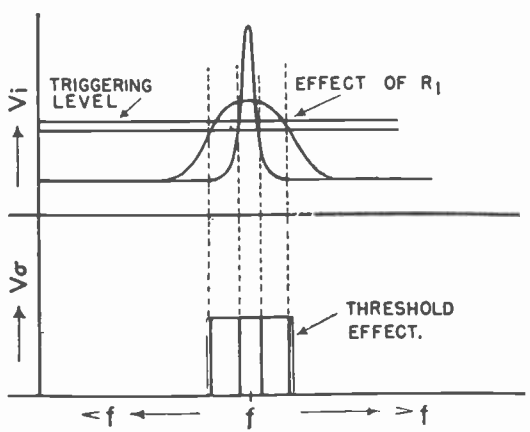

Fig. 1*d*.

2.4 *Final Characteristics*

Figure 2*a* shows a schematic diagram of the final filter circuit, in which there is no threshold effect. It will be noted that it differs from the basic circuit in two ways ; firstly, instead of a double triode two separate valves are used, the second valve having a longer grid base than the first, and a very different $Ia Va$ characteristic—Fig. 2*b* and *c* ; secondly, a resistance capacity network is included between the two valves. The result of these two modifications is that a greater voltage is required to trigger V_2, and the voltage pulses generated during the period of self-oscillation do not build up to a sufficient level through the network to operate V_2.

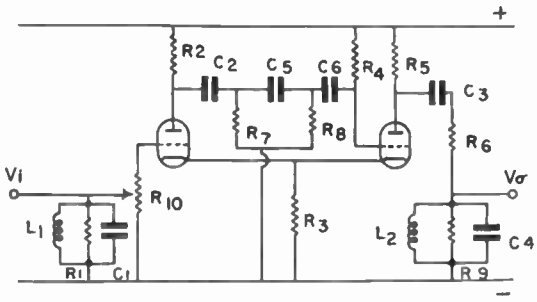

Fig. 2a.

The final characteristic of the valve assisted filter is as shown in Fig. 2*d*, the damping resistance R_9, being included to flatten the response. A variation of band-width over a range of some 800 c/s or more, dependent on the mid band frequency, is obtainable by adjusting R_8, and a filter having a band-width as small as 7 or 8 c/s is obtainable. Low, high, and multi-range band pass filter characteristics may be produced by selecting suitable reactive elements for the input and output circuits, and any gain or loss ratios are attainable by the inclusion of an output amplifier, cathode follower, or attenuator network. An input voltage of approximately 7V is required to trigger the circuit and in some cases it may be necessary to include a pre-amplifier circuit. Providing the input level exceeds the required triggering level, its magnitude is of no account, and levels up to 50 V or more will not introduce any appreciable distortion. As it is so simple to produce a narrow band filter of this type, it is unlikely that it will be necessary to feed two or more frequencies within any one band pass,

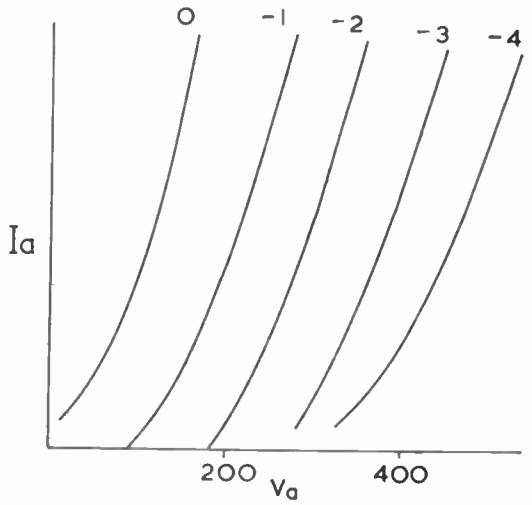

Fig. 2b.

simultaneously. If, however, it is required to do this, the separate frequencies may be selected in the output circuit by suitable tuned circuits fed in parallel to L_2C_4.

2.5 *Conclusions*

It has already been stated that it is not claimed that the valve assisted filter described is capable of universally replacing the coil and condenser type ; in order to assess its particular advantages a résumé of its characteristics are set out below :

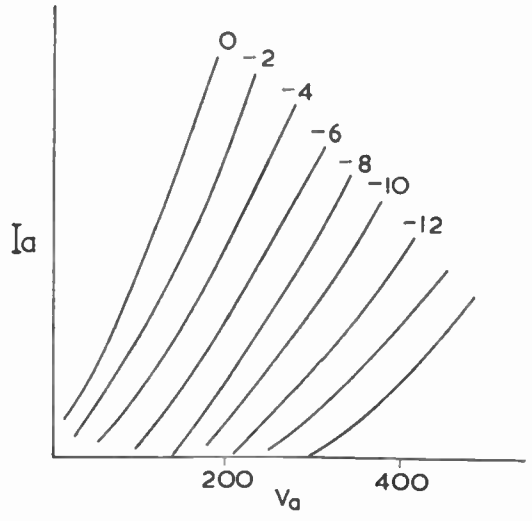

Fig. 2c.

2.5.1. It is possible to produce a valve assisted filter which end to end, meets the general loss or gain/frequency, and inpedance performance requirements of a coil and condenser filter.

2.5.2. It is possible to obtain infinite rejection outside the pass band, and an extremely sharply defined rejection point.

2.5.3. The output waveform is a pure sine wave if the band-width is less than 50 per cent. of the mid band frequency, and only slightly distorted outside this range.

2.5.4. It is possible to vary the band-width very easily, and to produce an extremely narrow pass band with no greater difficulty than a wide one.

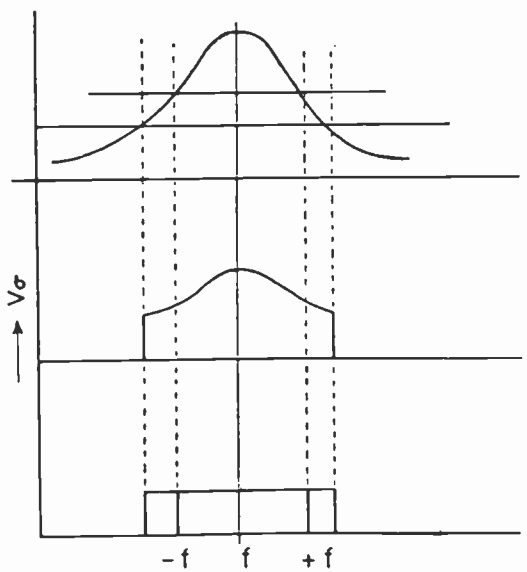

Fig. 2d.

2.5.5. The range of the filter may be easily varied by altering the resonant frequency of the reactive input and output circuits, thus making it possible to produce a multi-range band pass filter with excellent characteristics and an almost unlimited range.

2.5.6. There will be a considerable phase difference between the input and the output voltages.

2.5.7. A power supply is required : this type of filter is more suitable where a large number is required rather than only one.

2.5.8. The circuit is regenerative, the output voltage being produced as a result of the input, but not containing any component of that voltage. Therefore any distortion or noise modulation of the input will not necessarily be reproduced in the output.

2.5.9. The output voltage will be of constant level, providing the filter with an inherent limiter characteristic.

2.5.10. The cost of the filter is less than one quarter of an L.C. filter with only indifferent characteristics, it contains no high grade components, is easily lined up and no part of it requires expensive or accurate test facilities.

In general, it may be said that although the valve assisted filter does possess certain characteristics which are not altogether desirable, it has certain undeniable advantages for particular applications. Among these applications, to mention only a few, are, voice frequency telegraph and telephone systems, variable test filters for laboratory use, voltage limiters where a frequency characteristic is an advantage, and in frequency shift radio transmission systems. This latter application is dealt with in some detail in Section 2 of the paper.

3. Practical Application

3.1. *General*

In order to illustrate the practical value of the valve assisted filter, two circuits will be described in both of which this filter replaces the conventional coil and condenser type. The examples are of frequency shift converter systems, this particular application being chosen because firstly, a power supply is an essential of a frequency shift converter, and suitable voltages for the valve assisted filter are obtainable without additional equipment ; secondly, some form of voltage limiting is essential to such a system and it is therefore possible to make full use of the limiting property of the filters. Two designs are described ; the first is of a relatively simple nature and is intended to illustrate a method of utilizing the valve assisted filter in a way that would not be possible with a coil and condenser filter ; the second is rather more complex and in this case the valve assisted filter performs a similar function to a coil and condenser filter, but combines the process of voltage limiting.

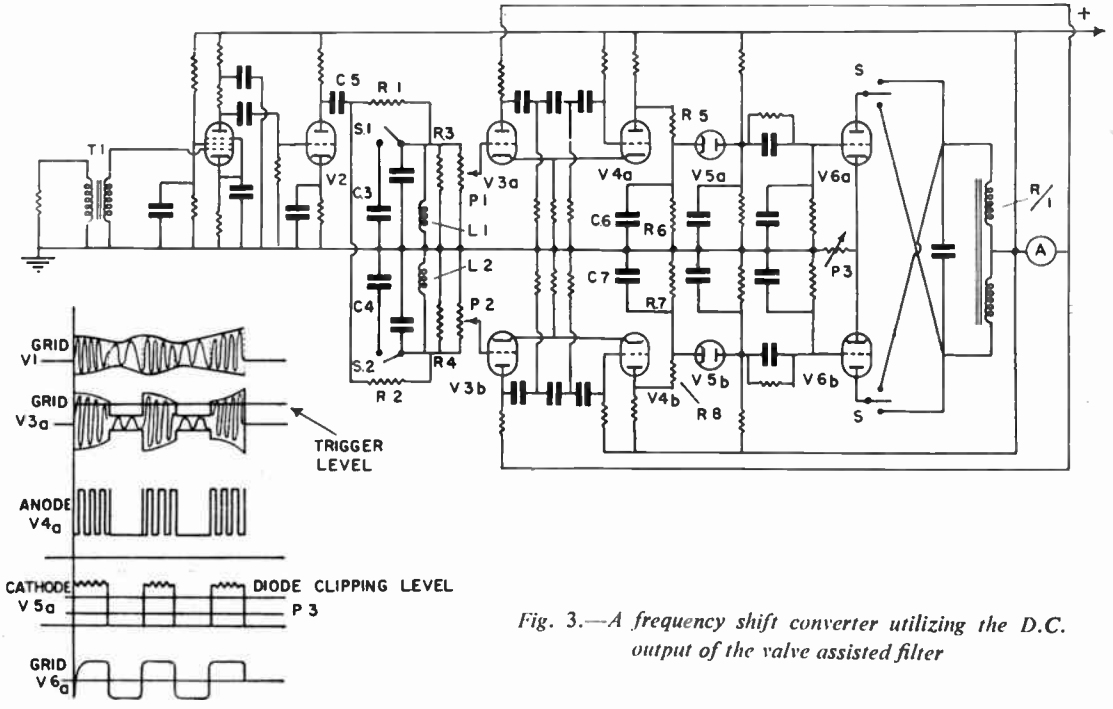

Fig. 3.—A frequency shift converter utilizing the D.C. output of the valve assisted filter

3.2. *Performance Requirements*

It is not within the scope of this paper to discuss the relative merits of the various systems used for converting the received signals of a frequency shift type of radio teleprinter transmission, into a voltage suitable for operating the receiving teleprinter. Many arguments have been put forward for and against systems employing channel filters versus those using discriminators, and for and against those working at intermediate frequencies versus those working at audio frequencies. In practice the choice of system must depend on the performance required, for each one is superior in performance to the others under some particular set of conditions, and as it is not possible to combine them all, a sacrifice must be made in some direction.

The systems described were designed with a view to military usage in the field, and had therefore to be extremely flexible and capable of being operated by semi-skilled personnel. The points following are set out as being the general performance requirements.

3.2.1. The equipment must be capable of producing an output to operate a teleprinter or undulator, either directly or remotely, with a minimum of distortion of telegraphic characters.

3.2.2. It must produce intelligible characters from a weak signal, a signal having a one-to-one signal/noise ratio, or a signal having an unwanted station of greater signal strength, but of different modulation frequency, on the same carrier.

3.2.3. It must operate from the audio frequency output of a standard communications receiver, and accept signal speeds of from 45-90 bands, and carrier shifts from 100-1,000 cycles.

3.2.4. It must function efficiently during a fade of signal to a level 25db below one milliwatt, and not produce distortion should the signal strength rise to a level of 20db above one milliwatt.

3.2.5. It must continue to operate satisfactorily from one side of the transmission should the other side fade completely, thus utilizing the diversity effect obtained by a carrier shift type of transmission at the lower carrier frequencies,

where the ratio of frequency shift to carrier frequency is large.

3.3. *Circuit details—first system*

Figure 3 shows a schematic diagram of the relatively simple converter. The audio output from the receiver is applied via T_1 to the cascade amplifier comprising V_1 and V_2. The gain of this amplifier is greater than 25db relative to one milliwatt, and the output voltage is fed via C_5 and R_1R_2 to two separate valve assisted filters. The switches S_1 and S_2 are ganged, and by switching in condensers C_3 and C_4 the range of the filters may be altered completely. A fine control of bandwidth is provided by P_1 and P_2 which are adjusted to produce a filter of sufficient width to accommodate the baud speed of the transmission, but not wide enough to accept any unwanted adjacent signal. The characteristics of the two filters are shown in Figs. 5*a* and 5*b*, relative to a centre frequency, *f*, the pass bands may be switched to cover a frequency shift of from 100-800 cycles or from 600-1,200 cycles, the receiver being tuned so that each side of the transmission falls within one filter channel. In order to ascertain when the receiver is correctly tuned, the combined anode currents of V_3a and V_3b are fed through a milliammeter. The total current at any one instant, when a correctly tuned signal is applied, will be the steady current of one valve, for at any one instant there will be signal on one grid only. Thus a steady deflection of this meter indicates that the system is in tune.

The filter outputs are fed off as square waves, these being applied via R_6 and R_8 to the filter networks C_1R_6 and C_7R_7 respectively. The D.C. built up across R_6 and R_7 is clipped by the diodes V_5a and V_5b, passed through a further filter network to remove any modulation or transients which may still be present, and applied to the grids of the keyer valves V_6a and V_5b. The bias on the keyer valves, which are cathode coupled, is variable ; the net result of the clipping by the diodes and the biasing voltage developed by P_3, is to take a slice from the centre of the D.C. baud, which should be reasonably free from noise, Fig. 3. A telegraph relay is connected between the anode of V_6a

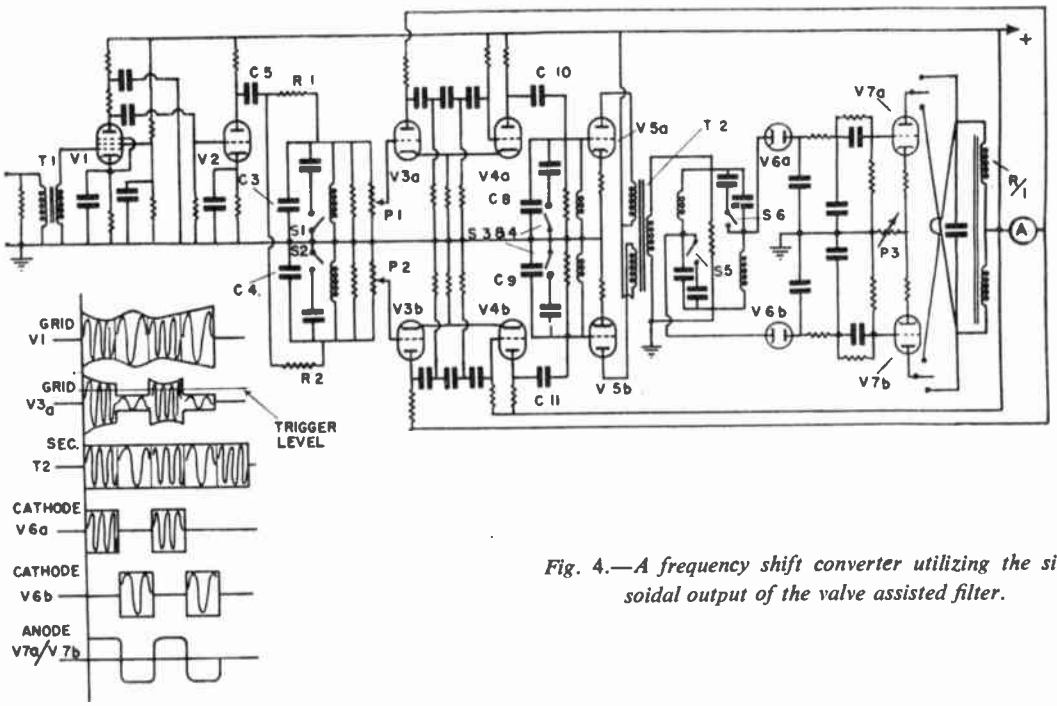

Fig. 4.—A frequency shift converter utilizing the sinusoidal output of the valve assisted filter.

and V_6b, the switch S, being included to enable the keying condition, mark or space, to be reversed relative to either audio tone. Thus should the undulator tape appear upside down it may easily be inverted. Each half of the circuits is working from one audio tone of the receiver output, and is completely independent, the relay R/1 being keyed equally well by either or both the keying valves. Should one half of the signal fade, and noise appear in its place, the bias developed by the half of the signal still present will prevent the relay keying from this noise. The contacts of R/1 may be used to key a D.C. source and operate an undulator or teleprinter direct, or to key a tone oscillator, the output of which may be fed through a line system for remote control.

3.4. *Circuit details—second system*

Figure 4 shows the schematic diagram of a more complex frequency shift converter. The circuit and operation are similar as far as the input to the two valve assisted channel filters, but in this case each output is developed across a damped tuned circuit and fed to an amplifier valve. The outputs of the amplifier valves V_5a and V_5b are added together in a push-push transformer and the secondary voltage of some 20 volts magnitude at low impedance is fed to a discriminator circuit. The switches S_{1-6} are ganged and the overall frequency characteristic of the converter may be varied over the same range as that of the converter previously described, Figs. 5*a*, *b* and *c*.

The introduction of the discriminator enables the system to work satisfactorily from a transmission having a very poor signal/noise ratio, as any noise which is able to make its way through the channel filters, will appear in equal magnitude on each side of the discriminator, and produce an equal and opposite D.C. kick on each of the keying valves simultaneously. The net effect is zero, the keying relay is not operated and thus no corruption of printer or undulator copy results.

The output of each side of the discriminator is fed through the diodes V_6a and V_6b respectively to a resistance-capacity filter network which removes any modulation from the D.C. baud, and thence to the grid circuits of the keying valves V_7a and V_7b. The remainder of the system is similar in performance and circuitry to that described in paragraph 3.3.

3.5. *Conclusions*

As may be anticipated, the performance of the latter system is superior to the one described initially in poor reception conditions of heavy noise and interference ; both systems however, have proved extremely stable, and in comparison tests the latter system in particular has proved itself equal in every way to several types of well-known commercial systems, working at both audio and intermediate frequencies. The comparison of cost is extremely favourable, for no high grade or close tolerance components are required, and replacements provide no difficulty. The mechanical size and weight of the converter also provide points in its favour, midget valves may be used, and it is particularly suitable for mobile use.

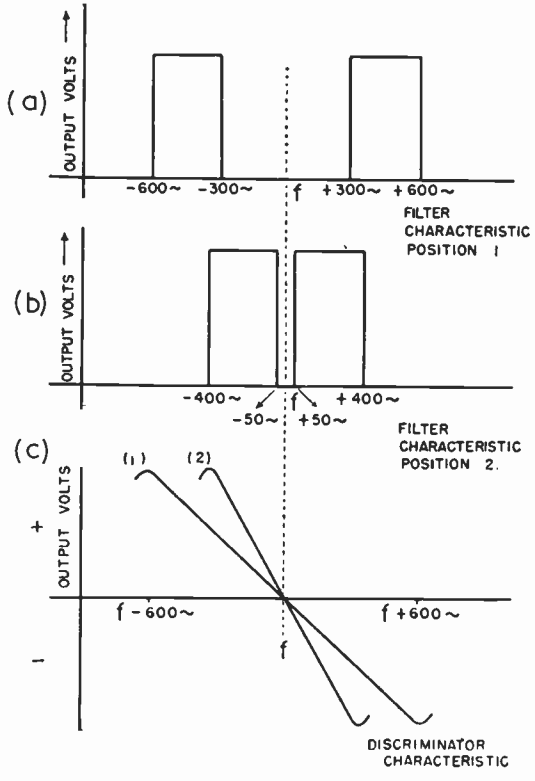

Fig. 5.

3.6. *Acknowledgments*

The author is indebted to M. D. Mason, M.B.E. for suggesting the possibility of the application described.

NOTICES

Honours

The Council congratulates Mr. Sydney Alfred Hurren on his appointment as an Officer of the Most Excellent Order of the British Empire, on the occasion of His Majesty's Birthday

Elected a Member of Council in 1937, Mr. Hurren was President of the Institution from 1938-1941 and was made an Honorary Member in 1945.

G.E.C. Conversazione

A "Conversazione" was arranged at the Research Laboratories of the G.E.C., Wembley, from June 21st to June 23rd to show, as far as possible, the laboratories under normal working conditions. The Secretary of the Institution was invited, together with representatives of all branches of industry, and scientists and technologists from universities and other research establishments.

In the radiocommunications section the V.H.F. frequency modulation area coverage for fixed mobile communication was being shown. In this system greater area coverage than that of a single transmitter is obtained by synchronizing the frequencies of one or more remote transmitters. The V.H.F. multi-channel project was also in this section. This system provides a long distance two-way, six-channel multiplex circuit using radio links.

In the television section pulse techniques were demonstrated, including the methods of generating very short pulses of ·01 microseconds duration and their transmission through delay lines and filters. Apparatus being supplied for the London-Birmingham Television Radio Link included an aerial system, a contactless R.F. switch and circuits for use in radio frequency stages of transmitters.

Other items of interest included a demonstration of the assembly and applications of germanium crystal rectifiers, the applications of quartz and synthetic piezoelectric crystals in ultrasonics, and a demonstration of the various processes used in making cathode ray tubes.

The arrangements made by the General Electric Company were very good ; in particular, thanks are extended to the staff on duty who were exceedingly helpful. It is hoped that this "Conversazione" will become an annual event and that it will lead to further collaboration between industry and professional organizations.

Radium and Radon for Industry

The Ministry of Supply wishes to make known to Industry that the Radiochemical Centre at Amersham can now accept orders for radium and radon as sources of gamma rays for use in industrial radiography.

Capsules containing 50 mg and 250 mg of radium are supplied only on hire for periods of not less than six months. Radon is sold outright ; 250, 500 and 750 millicurie sources are available.

The Radiochemical Centre requires written confirmation from applicants that their safety arrangements are adequate.

N.P.L. Open Day

On May 26th and 27th the National Physical Laboratory held their annual "open days." Early in 1948 a separate Electronics Section was set up to further the application of electronic techniques to industrial processes and to develop the high speed electronic digital computer. This had a complete room to itself, special attention being paid to the process of binary computation and to the working of the supersonic delay line incorporated in the memory unit. In the same section two applications of cavity resonators in the determination of the velocity of light and the measurement of dielectric properties in the region of 100 Mc/s were of particular interest.

Various applications of electronic devices to industrial processes were noteworthy. These included a capacitance type moisture meter, an apparatus for the measurement of elastic constants using the ultrasonic pulse technique, and a strain actuated electronic trigger.

R.D.F. equipment for the location of thunderstorms and the standard frequency quartz oscillator for testing chronometers were also shown, but they had appeared at previous open days.

The new section of the N.P.L. set up to study ultrasonics produced a very interesting display. This included a number of different types of transducers, a demonstration of a simple supersonic delay line and a demonstration of an ultrasonic equipment used for testing the thickness of concrete.

Finally, the N.P.L. must be congratulated on the organisation of this open day, the enthusiasm of members of the staff in the demonstration of the apparatus being especially noticeable.