Communication and Broadcast Engineering

VOL. 2 NO. 9

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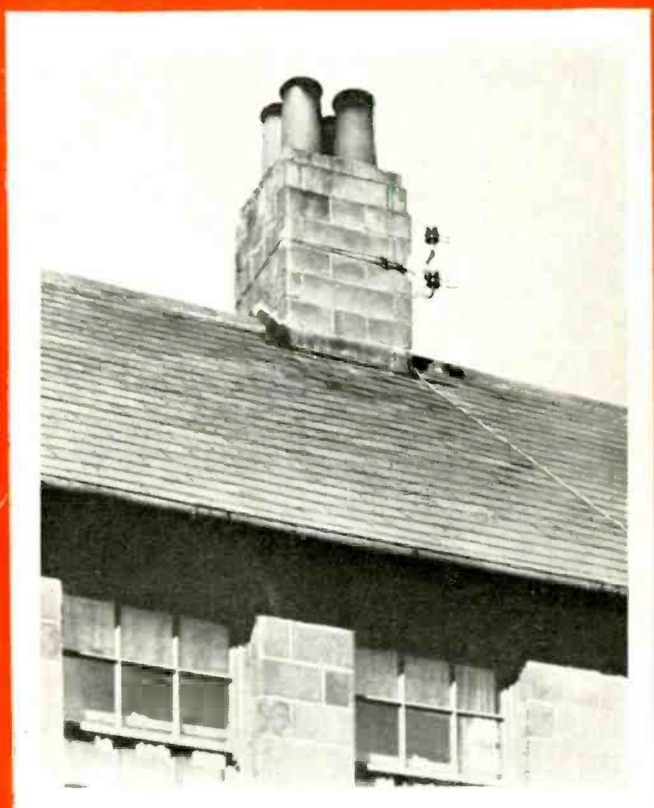

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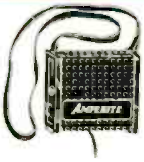

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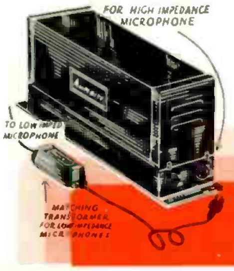

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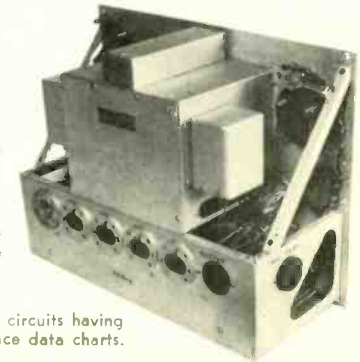

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EDITORIAL

TELEVISION- III

TELEVISION IS no longer in the lap of the gods—it now rests in human hands. The future of television—its utilitarian and cultural scope, and the rapidity with which it progresses—is solely dependent upon how the human hands may propose to mold it.

It has been pointed out that haste in promoting television might do irreparable damage; that lack of standardization with regard to the technical points might bring about chaos; that inadequate transmission facilities might "kill the goose" before it ever laid a golden egg. In short, television will demand that the stage be set well in advance of the play.

It is a foregone conclusion that the industry has given serious consideration to the technical problems peculiar to television. Consequently, it may be assumed that the system or systems placed into service will be practical and compatible. Perhaps, though, the industry has failed to take into account the equally important problems of the technique of presentation and the social ramifications. In the instance of television the success or failure of its service will hinge as much upon the manner in which it is conducted as upon technical merits.

Radio broadcasting had a clear-cut field to begin with, and, because of its nature, became the exclusive child of the radio industry. Television, on the other hand, though based on radio practice and on the efforts of radio engineers, may remain a child of this industry only in the event that its use is kept within proper bounds. There is the possibility, for one thing, of there being too many cooks, and there is the chance that television may develop into the ward of an industry or profession other than radio. Certainly the fruits of television should go to the industry from which it evolved. Should the fruits go elsewhere, the radio and television engineer, and the radio industry, will have been exploited.

We are of the opinion that the radio industry should commence a study of the possible implications of a television service; that immediate consideration should be given to the interests that may be involved; that a committee should be formed for the purpose of developing a technique of presentation in fitting with the technical scope of the proposed television service; that representatives of the industry should cooperate for the express purposes of preventing the institution of conflicting systems, and to *direct* the functioning of the service. It is not enough that the industry should control the television chains; the industry should also control the uses to which the chains are put.

The danger of leaving the formulation of television technique in the hands of business interests lies in the fact that such interests lack entirely the technical foresight of the engineer. If sufficient foresight is not exercised in the formulation of the system, the chains may start their march of progress with the wrong foot forward . . . and be unable to change step, once they have started.

Television is destined to have a marked influence on social life—good or bad. It may in time play a more important part in the shaping of human relationships than has the automobile. If used as an educational medium, it will enlighten and broaden the average mind to a far greater extent than has radio broadcasting. If used as a vehicle for entertainment, it will enrich the lives of millions of people. If used principally as a commercial service, predicated upon the identical set-up of radio broadcasting, it may well fall into disrepute.

In order to insure the future of television, the radio industry should commence immediately the shaping of television policies. Prepardness is an essential, if television is to be the next milestone in the progress of society. And prepardness is an essential if the radio industry is to rear its own child.

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COMPACT

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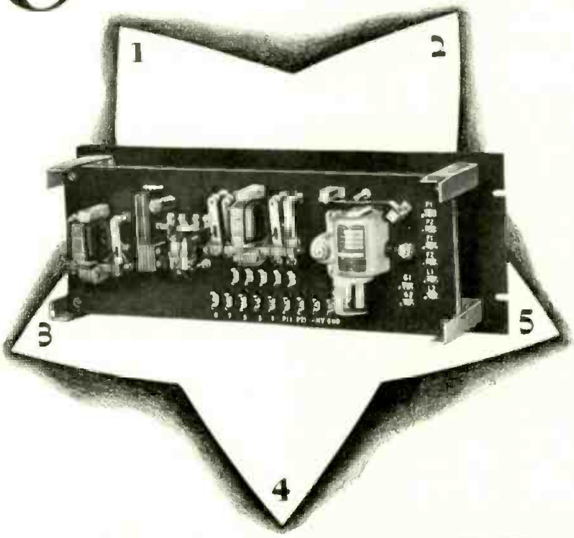

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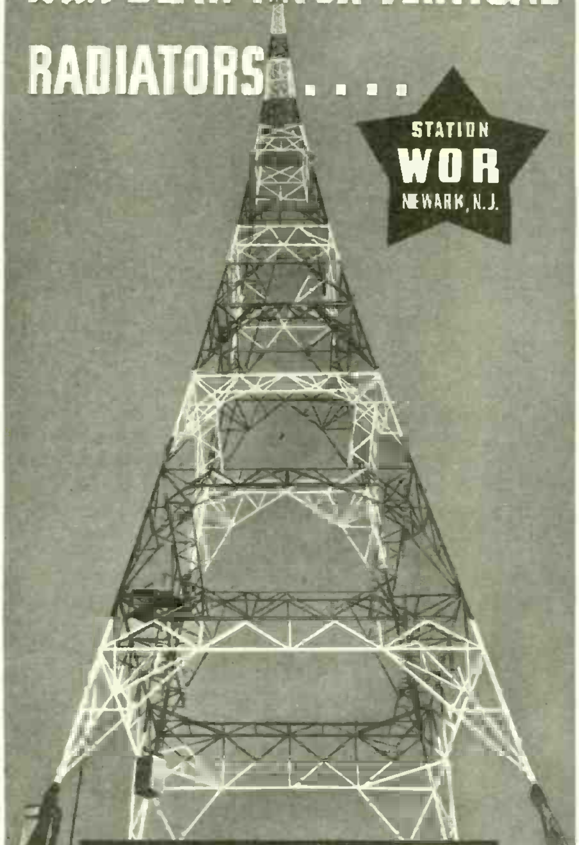

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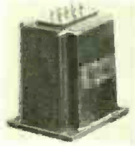

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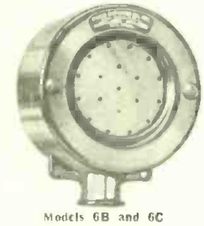

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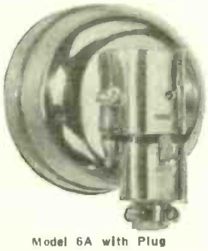

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COMMUNICATION & BROADCAST ENGINEERING

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REDIFFUSION IN GREAT BRITAIN

The First of Three Articles on the General and Technical Aspects of Program Service by Wire

By PAUL ADORJAN
Director of Research
REDIFFUSION, LIMITED, LONDON, ENGLAND

OVER A QUARTER of a million families in Great Britain receive their radio entertainment by wire. This method of distributing is known as "Rediffusion" (also as Radio Relay and Broadcast Relay).

Selected radio programs are picked up at suitable points and the amplified signals are carried by private wires to subscriber's premises for the operation of sound reproducers.

The technical services for the group of companies supplying over a quarter of the total number of subscribers are carried out by Rediffusion Limited and the present article deals with the methods employed by those companies, but the remaining companies are run on similar lines as far as general principles are concerned.

It is interesting to note that the Rediffusion systems described here have been the most successful as regards the number of subscribers per families residing in their respective areas. In some areas every fourth family subscribes to the Rediffusion service.

CONDITIONS OF OPERATION

A license from the Postmaster General and permission from the local town council must be obtained before any town can be operated. Where roads have to be crossed with overhead or underground wiring, permission must be obtained from the authorities while wayleaves from both landlords and tenants are required not only for any fixings to private property, but also for all wires passing over private property.

RECEIVING STATIONS

Rediffusion systems usually operate in towns where radio reception is bad owing to electrical interference and/or weak field strength. The first problem, therefore, that the Rediffusion engineer has to solve is to find a suitable receiving site. Observations of field strength with particular reference to fading are carried out over an extended period and when a suitable site is found, usually some distance from the town concerned, a receiving station is erected. A typical receiving station is shown in Fig. 1.

FIG. 1. A TYPICAL "REDIFFUSION" RECEIVING STATION.

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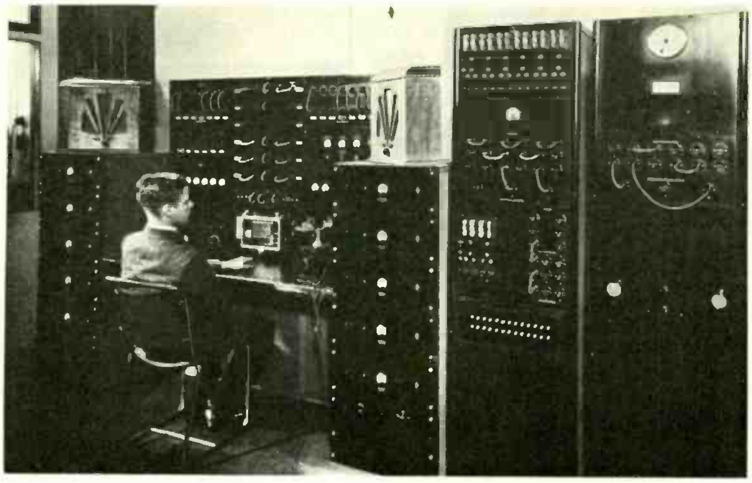

FIG. 2. INTERIOR OF A CENTRAL CONTROL STATION.

The aerial systems generally include directional aerials as these are found to be very useful for eliminating various types of interference.

The receiving station usually contains four receivers. The types of receivers used vary according to the conditions at the receiving station. If the receiving station is within the primary service area of B. B. C. stations one or two straight receivers are used for the reception of these programs while the remaining receivers are of the superheterodyne type used for the reception of more distant British, Continental and Transatlantic transmissions. The wave range covered by the various types of receivers is from 16 to 2000 meters.

If B. B. C. transmitters are within 20 miles, diode receivers without a high-frequency stage are employed for the reception of these transmissions. If the B. B. C. transmitters are within two or three miles, it is usual to install a diode receiver right under the transmitting aerial and connect the audio-frequency output of this receiver via Post Office lines to the central control station.

The output of the receivers is connected by means of line amplifiers to Post Office lines or company's own lines connecting the receiving station to the central control station.

Suitable switching, fading and volume-indicating equipment is also provided at the receiving station.

CHOICE OF PROGRAMS

Two programs are supplied to subscribers for about 14 hours each day. The programs are chosen a week in advance for each town from the various British and foreign transmissions available. Approximately 90 percent of the transmissions consist of relaying British programs, no advertising matter being sent out. Under the terms of the license from the Postmaster General no programs may be originated by the Rediffusion companies.

CENTRAL CONTROL STATIONS

The central control station is situated approximately at the geometrical center of the town which is to be served. It is connected to the receiving station by two program lines and a telephone line which are either hired from the Post Office or are company's own lines. Switching arrangements are provided so that in case of breakdown of the program lines, the telephone line may be used as an emergency replacement.

A number of repeating line amplifiers are installed at the central control station to supply the programs to a number of sub-amplifying stations. A separate line amplifier is used for each sub-station and each program. Thus, if five sub-stations have to be supplied, ten repeating line amplifiers are required at central control. In addition to these, spares are available. Usually the central control station also contains power amplifiers for directly supplying subscribers situated around the central control station and each amplifying station supplies subscribers situated around it in an area with a radius of about one mile.

The central control station is connected to each of the sub-stations by three lines; these again are either rented from the Post Office or are the company's own lines. Two of these lines are program lines, while the third is a telephone and control line. By means of special control gear installed at the central control station and each sub-station, either of the programs can be monitored from any of the sub-stations at central control.

The sub-stations are not attended and the central control operator controls the output level of sub-stations and informs engineers of any irregularity that he may observe. A service engineer is then dispatched, probably on a motorcycle, to the sub-station to deal with the fault.

Central control gear is now being installed to enable central control to switch on and off equipments at sub-stations and transfer amplifiers from one program to another in order to deal with variations in load conditions.

Synchronous clock switching gear is installed in all sub-stations to earth subscriber's feeders after midnight. when the programs are terminated. This switch at present is also used for switching off equipments.

Level indicators are connected across all interstation lines and all power amplifier outputs.

Fig. 2 shows the interior of a central control station. The central control room is usually adjacent to the demonstration room where intending subscribers can choose their loudspeakers. Fig. 3 shows a typical demonstration room, with the control room in the background. The various types of subscriber's loudspeakers can be seen in this figure.

FIG. 3. DEMONSTRATION ROOM, WITH CONTROL ROOM IN THE BACKGROUND.

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FIG. 4. EXTERIOR OF AN UNATTENDED SUB-STATION.

SUB-AMPLIFYING STATIONS

Fig. 4 shows the exterior of an unattended sub-station. The aerial in the background is used in connection with a standby receiver. Where such standby receivers are installed arrangements are provided for automatic switching on from central control and also for reversal of line amplifiers. This arrangement is provided so that in case of breakdown at the receiving station alternative reception shall be available, such alternative reception, of course, being generally inferior to that normally available.

The sub-station houses line amplifiers, control gear and power amplifiers. Two types of power amplifiers are employed, (1) approximately 100 watts output, (2) approximately 300 watts output.

The type used at any sub-station is decided on after consideration of the number of subscribers to be served by the particular station, only one type of power amplifier being employed at each station.

FIG. 7. A HIGH-LEVEL STATION. THIS SUPPLIES THREE TOWNS.

The gain of all amplifiers in a station is adjusted to be equal so that it is possible to run two or more amplifiers in parallel under heavy load conditions.

PERFORMANCE OF EQUIPMENT

The frequency response of all amplifiers is kept within 1 db from 50 to 10,000 cycles. The total harmonic distortion produced by the combination of line and power amplifier is limited to 5 percent on the rated full outputs. The inter-station links are equalized to within 2 db from 50 to 6,000 cycles, or 50 to 9,000 cycles, depending on the length of the lines. It would be a comparatively easy matter to equalize all inter-station lines to 9,000 cycles, but at present this is unnecessary as owing to the unsatisfactory separation between adjacent transmitter channels, the response has to be cut down by selective receivers.

Where Post Office lines are used, the levels applied to these must not exceed 1.4 volts rms, but on the company's own lines levels of 35 to 45 volts rms are usual. All power amplifiers are designed to supply 45 volts rms under the conditions of full output and full load. Output wattages of 25 percent to 50 percent higher than the normal rated outputs can be obtained with about 10 percent total harmonic distortion.

All power amplifiers are of the Class AB type and therefore high efficiencies are obtained.

DISTRIBUTING NETWORK

The company's own lines are used exclusively between the amplifying stations and subscribers, these lines being tested daily with equipment provided at all stations. Four wires are used for the transmission of two programs, two for the program known as "A" program and two for the alternative or "B" program. Six or eight main feeders are erected radially from each amplifying station and all subscribers are wired in parallel along these feeders and branch feeders.

Open wire is preferable from the point of view of obtaining good frequency characteristics, but lead cable and underground cabling are used to a large extent. All main feeders are constructed in 16 gauge conductors, 20 gauge lead covered cables being used for subscriber's drop-ins.

Open wire feeders are carried along chimney stacks, held by suitable brackets, while lead cable is usually run under the eaves. Fig. 5 (front cover) shows the method of construction of open wire, and the subscriber's drop-in can also be seen. Note the special pothead insulators employed.

The frequency response of the distributing network varies according to the proportion of open wire and lead cable and also with the load, but with

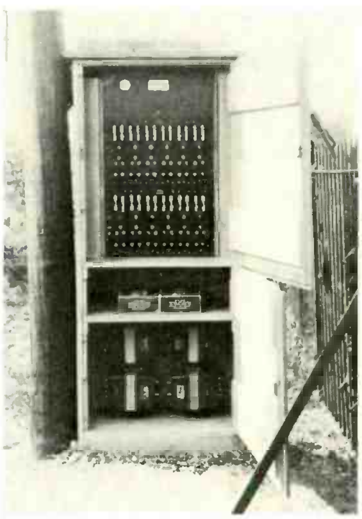

FIG. 6. CASE CONTAINING THE STEP-DOWN TRANSFORMERS AND LINE-TESTING EQUIPMENT.

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FIG. 8. EQUIPMENT ROOM IN HIGH-LEVEL STATION.

relatively simple equalization, it is possible to obtain fairly even response to 6,000 cycles. Methods are now being developed for extending the range of the distributing network to higher frequencies.

SUBSCRIBER'S INSTALLATIONS

At the subscriber's installations a three-way switch ("A" program, Off, "B" program) is installed and this is used as a termination of the wiring. A moving-coil loudspeaker is connected to this switch and a volume control is incorporated in the speaker.

The normal charge for the service is 1s. 6d. per week, on top of which the subscriber buys the loudspeaker (for cash or weekly installments) and he also has to buy a Post Office wireless receiving license (10/- per annum). No additional charge is made for installation or maintenance.

HIGH-LEVEL WORKING

Under certain conditions it is found more economical to transfer audio-frequency power from amplifying stations at a relatively high voltage (150 to 300 volts maximum rms) to various transformer points where the voltage is stepped down to the normal service level (35 to 45 volts rms). Water-proof transformer boxes containing transformers and line-testing gear are used at such points. Fig. 6 illustrates a typical transformer box.

In one particular case it was possible to find a suitable site where receivers and amplifiers could be centralized and three towns are now supplied from this point at high voltage, the only equipment used in the towns being the equipment housed in the transformer boxes, as shown in Fig. 6. The station building of this system is shown in Fig. 7 and the equipment room is shown in Fig. 8. The receivers and control gear are shown in the foreground while the amplifier and line-testing equipment mounted on bays is installed behind the control desk. This station now has amplifiers capable of an undistorted output of 1½ kw and at present serves over 3,000 subscribers.

Results show that the quality of the programs received by Rediffusion subscribers is definitely superior to that received by average broadcast receivers and from the rapid growth of the system it can be predicted that eventually a large proportion of the listeners in Great Britain will receive their radio entertainment by Rediffusion.

(*To be continued*)

BOOK REVIEW

PRACTICAL RADIO COMMUNICATION, by Arthur R. Nilson and J. L. Hornung, published by McGraw-Hill Book Company, Inc., 330 *West* 42*nd Street, New York, N. Y., first edition,* 754 *pages, price* $5.00.

As the name implies, this is a practical book covering the field of radio communication. This book was planned to meet the expanded scope of technical radio developments, and was written to provide within one volume most of the technical information required by the practical radio operator-technician.

The authors state that "The book is divided roughly into two parts: Principles and Practice. The first six chapters are given over to principles and the remaining nine chapters to practice. High-grade technical skill is always founded on a sound basis of fundamental principles. It has been our purpose, therefore, to go into these principles extensively, delving deeply into alternating current, which plays an important part in modern radio. It is on the assumption that these principles have already been mastered that the practical sections of the book have been written. In fact, it is necessary that these principles be understood before the practical sections can be read intelligently."

Chapter I, entitled "Direct-Current Electricity and Magnetism," has been divided into three parts. The first part covering "Elementary Electricity" begins with the customary electric charges and forces, protons, electrons, potential, and the like, and ends with dry cells, the telephone receiver and transmitter. Part two discusses "Magnetism and Electromagnetism," covering natural and artificial magnets, poles of a magnet, magnetic fields, theory of magnetism, production of an electromotive force by a field cutting a conductor, etc. The third part deals with the magnetic circuit covering Ohm's law for the magnetic circuit, computations, and hysteresis.

Chapter II has been given over to the subject of alternating currents, the subjects of alternating-current generation and transformation, inductance, capacity, and the elements of alternating-current engineering each receiving their allotted space.

The third chapter discusses vacuum tubes, their characteristics, radio-frequency amplifiers, and vacuum-tube oscillators. Chapters III and IV are entitled "Transmitting-Circuit Principles" and "Receiving-Circuit Principles," respectively. The next chapter is devoted to "Antennas and Wave Propagation," including antenna measurements and calculations.

"Studio Acoustics and Apparatus" and "Control-Room Equipment and Operation" are the title of Chapters VII and VIII. Additional chapters on Broadcast Transmitters, Communication Transmitters, Radio Receivers (including all-wave, aircraft, marine and police), Radio Aids to Navigation and Rectifier Units follow; while the last two chapters in the book cover Electric Machines and Meters and Storage Batteries.

Two appendices are also included. Appendix A gives technical information, charts and tables, and Appendix B is devoted to operating information of various sorts.

While the authors have succeeded in making *Practical Radio Communication* a book to be recommended to the practical radio operator-technician, they have also written a book that will make a worthwhile addition to any radio engineer's library.

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RADIO DESIGN PRACTICE, edited by James Millen, with drawings by M. B. Sleeper, published by James Millen, Inc., Malden, Mass., 260 *printed pages, looseleaf binding with board cover. Price* $1.00.

Radio Design Practice. First Edition, 1935, is an unusual compilation of

(*Continued on page* 13)

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HIGH-SPEED SYNCHRONOUS DISTRIBUTOR

By PAUL von KUNITS
Research Engineer
BRUNO LABORATORIES

IT WAS THROUGH a problem faced by one of America's leading communications companies that the synchronous distributing systems came to be evolved. Handling press dispatches from coast to coast via a series of radio stations, this company had found their facilities badly overloaded during certain periods of the day. The total amount of traffic involved could have been handled by steady transmission over a full daily period, but due to the nature of the material this was impossible.

PROBLEMS INVOLVED

To cite an example of the conditions involved, let us suppose the Chicago transmitter to be busy sending a play-by-play description of a ball game to San Francisco. During this time it becomes necessary to send certain dispatches to New York if they are to make their scheduled editions. Either transmission to San Francisco must be broken off, or the New York dispatches lost. Either way the company is losing the good-will of an important customer.

In order to solve the problem, an additional set of sending and receiving channels seemed a necessity. The tremendous expense involved in their erection made this solution unfeasible, however, as the amount of traffic they would have to carry would never justify their cost.

After much discussion it was decided that, as at many times the channel was tied up with traffic of a semi-continuous nature (i.e., one having momentary pauses, such as play-by-play descriptions or "ticker" service), advantage could be taken of these pauses to transmit other news. The solution involved the use of a high-speed synchronous switching system to be operated at both transmitting and receiving ends. Before describing the system, however, it might be advantageous to review briefly modern methods of automatic press transmission and reception.

AUTOMATIC PRESS TRANSMISSION

News to be transmitted is first "printed" as perforations on a tape by a machine closely resembling a typewriter in appearance. The perforated tape is then fed into an automatic transmitting machine. This machine translates the perforations into electrical impulses which are sent out via either radio or wire as the case may be. At the receiving end the incoming signal is caused to actuate a relay which in turn operates the selecting mechanism of a printing machine. The printing machine thus translates the incoming pulses directly into typewritten characters. Standard transmission takes place at the rate of sixty words a minute.

The fundamentals of the synchronous distributing system are as follows: Suppose the Chicago transmitter to be in operation and sending two sets of material, one intended for reception at San Francisco and the other at New York. The operation of the tape machines feeding this transmitter is controlled by a synchronous distributor which turns them on and off alternately many times per second.

In New York and San Francisco are located duplicate synchronous distributors controlling the action of the printing machines attached to their respective receivers. The printing machine in San Francisco is turned on only during that portion of the time that the Chicago transmitter is being fed material intended for it. Similarly the New York machine is only allowed to operate during the time Chicago is transmitting for it. Switching takes place at the rate of 240 switches per minute. During the time a transmitting machine is waiting to go ahead it can be "piling up" characters for that fraction of a second. This tends to reduce the waste time caused by pauses in the continuity of the material being sent.

DETAILS OF SYNCHRONIZING UNIT

Though the idea behind the system is

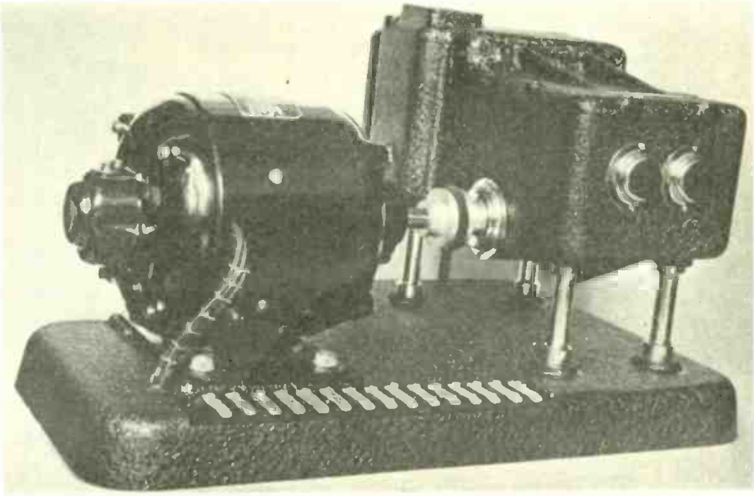

FIG. 1. VIEW OF THE HIGH-SPEED SYNCHRONOUS DISTRIBUTOR.

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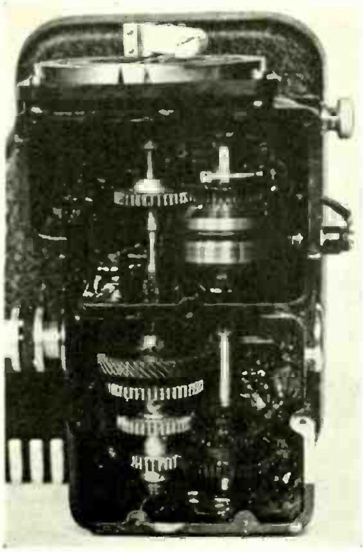


FIG. 2. INTERIOR OF THE CASE, SHOWING GEARS AND COMMUTATORS.

comparatively simple, the problem of keeping the distributors in absolute synchronism is most certainly not. The apparatus developed to answer this purpose is illustrated in Fig. 1. It consists of a motor-driven rotary switch arm which contacts a number of segments in turn, one segment for each desired channel plus one smaller segment used for synchronization. In action the arm rotates continuously, turning off or on in turn the desired machine as it passes over each segment. At the completion of one cycle and before the start of the next it must pass over the synchronizing segment. This causes the transmitter to send out a synchronizing pulse. At the receiving end a similar motor-driven switch is so arranged that it makes one complete revolution and stops on the synchronizing segment until released from this position by the next incoming synchronizing pulse. Thus the transmitting and receiving distributors must each start out at exactly the same point. As they are both driven by twin synchronous motors they should, theoretically, both revolve at exactly the same speed and stay in perfect step. However, if the motors have even approximately the same speed it is impossible for the system to get out of step as it is automatically re-synchronized at the beginning of each revolution.

A view of the switching and synchronizing segments is shown in Fig. 2.

OTHER APPLICATIONS

Since its inception it has become apparent that the synchronous distributing system has many other applications in the communications field. Among other things it makes available, in rapid rotation, as many separate transmitting and receiving channels as desired. Incidentally, the number of channels that can be utilized is limited by the speed by which reception and transmission can take place and not by the distributing system. With present-day practice observed, four channels are about the limit and the system described makes available that number.

It may not at first sight be apparent that anything is gained by having four separate channels if they can be used only in rotation. It is true that the total transmission time has not been changed but now the same transmitter can feed any number of receiving centers four separate messages at approximately the same time.

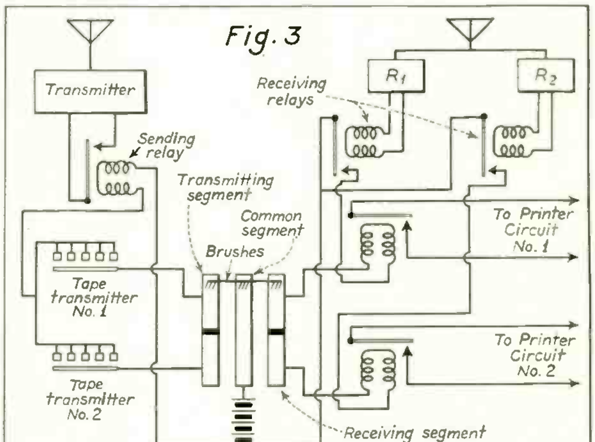
EXAMPLE OF APPLICATION

Let us take the following instance as an example: It is two o'clock in the afternoon at our New York transmitting center. There is scheduled to be sent a play-by-play description of the deciding game of the World Series to all of the receiving centers, and nothing must interfere with the instant transmission of this game. However, there is also scheduled to be sent a play-by-play description of another game of local interest only to Kansas City. Then there are also a series of news events. of interest to Chicago and Detroit, respectively, which must be sent during the afternoon if they are to make the desired editions. Under the old system, all traffic but the main event, the World Series, would have to be shelved and lost. With the synchronous distributing system in operation, all can be handled with ease.

There are now available four channels which can be distributed as desired. One would be made common to all receiving points and would handle the Series. One would handle the local game for Kansas City, another the local news for Chicago, and the last the local news for Detroit. Instead of steady transmission to each point, it is maintained only for one two-hundred-and fortieth of a minute and then lapses for three two-hundred-and-fortieths, repeating this cycle. The play-by-play descriptions are not delayed in the slightest as they consist of about three-fourths "dead time" between events. Working the printers and receivers, on the local news circuits, at their normal rate of speed they will only be able to transmit one-quarter of the number of words they could on solid time. However, this may be quite adequate to take care of this traffic which, without this system, would be completely lost.

FLEXIBILITY OF SYSTEM

Adding further to its flexibility such a system can be made to allow the transmitter to control the number and selection of the segments in use at the receiving end. This is accomplished by the transmission of "selecting" pulses at the time the brush arms are passing over the synchronizing segment. These pulses are of a distinctive frequency and each operates a particular time-delay relay at the receiving end. The relays cause the desired segments to be thrown into the circuit. If unactuated by further pulses on the next cycle, they automatically drop out of the circuit, having reached the duration of their delay. Thus, to go back to the example already cited, if a news flash of great importance were suddenly to come through during the various transmissions the transmitter would send out pulses causing all four segments at each receiving point to work full time for the duration of the flash. This arrangement also makes it an easy matter



SCHEMATIC DIAGRAM OF INDIVIDUAL STATION EQUIPMENT IN THE THREE-WAY DUPLEX RADIO TELEGRAPH SYSTEM.

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to switch in or out of the circuit any receiving point at choice.

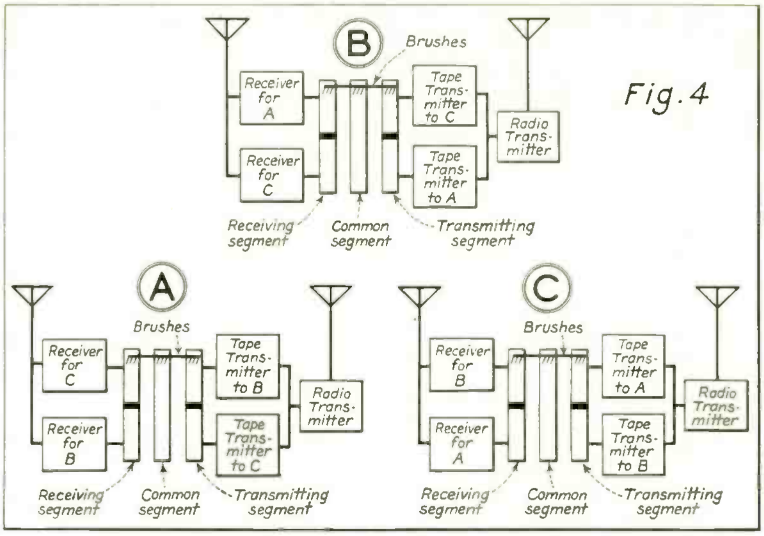
A TWO-WAY MULTIPLE SYSTEM

Another instance of the flexibility of the system is its adaption to the task of furnishing two-way communication between any and all of three receiving and transmitting points, without involving any dead time. A schematic diagram illustrating in detail the arrangement of the equipment at an individual station is given in Fig. 3. Fig. 4 shows the relations existing between each of the points at a given moment.

The only difference between the machines used for this purpose and those previously described is that the rotating arm now carries an extra brush so that it contacts two segments at a time. To make the working of the distributor clearer, the segments in the diagram are shown in a rearranged form.

The switch arm is the common connection for the tape printers and transmitters. All three distributors shown operate in synchronism. Thus, in the first position, Station "A" is transmitting news to Station "B" and receiving it from Station "C." Although Station "B" is transmitting news intended for Station "C," and Station "A" is getting it on the receiver it has tuned to "B's" wavelength, it does not print that news because the printer circuit for that receiver is open.

When contact is made to the next pair of segments at Station "A," it sets into operation the tape printer connected to the receiver tuned to Station "B" and now material from this station will be recorded. Station "B" however, is now sending material intended for Station "A." At "C" the receiver tuned to "B" has been automatically disconnected from its printer. During these times at Stations "B" and "C" similar actions have taken place.



SHOWING MOMENTARY CONDITION OF EACH STATION FOR TWO-WAY COMMUNICATION BETWEEN ALL STATIONS.

BOOK REVIEW

(*Continued from page* 10)

mechanical and electrical specifications of radio components and complete units. Your reviewer does not recall ever having seen anything quite like it in print. Mr. Millen refers to it as "An idea book for engineers, experimenters, and designers of radio and associated equipment." Certainly it should be of unending value to the design engineer, the amateur and the experimenter, who require precise component specifications.

As far as possible, all drawings have been made one-half size. These drawings were made from the actual parts themselves, and care has been taken to assure their accuracy in order that dimensions not given may be scaled off.

The First Section deals with the assembly practice of relay racks. Specifications are given for National and Western Electric units. The Second Section deals with transmitting- and receiving-type variable condensers. Specifications are provided in the latter part of the Second Section for high- and low-voltage fixed condensers; paper, mica and electrolytic.

Subsequent sections deal with dials, inductance forms, r-f chokes, coil and tube shields, sockets, insulators, resistors, switches, plugs and jacks, and meters. Companies represented are: National, General Radio, Electrad, Aerovox, Weston, and General Electric.

Specifications for National and Delta transformers and chokes are also included.

The Third Section covers National, Western Electric, and Federal receivers. The Fourth and Fifth Sections deal with Western Electric and Federal transmitters and speech-input equipment. The Sixth Section with special apparatus, such as signal generators, made by General Radio.

These sections are followed by 78 pages providing the characteristics and operating conditions for the complete line of Sylvania receiving-type tubes. No data are provided on transmitting type tubes.

Twenty pages are given over to design details, servicing data, etc., on the National HRO Communication Receiver. The last 24 pages in the book are National and Acme-Delta catalogue sheets.

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FUNDAMENTALS OF RADIO, by R. R. Ramsey (Professor of Physics, Indiana University), published by Ramsey Publishing Co., Bloomington, Indiana, second edition, 426 *pages, price* $3.50.

Probably the most satisfactory way of describing the nature of this book is to quote from the preface to the first edition written by R. R. Ramsey in 1929:

"In the *Fundamentals of Radio* I have endeavored to give the basic theory of radio as it is exemplified in modern practice. Perhaps if the fundamentals were limited in number to two, they might be given as the resonant, or wave meter circuit and the three-electrode vacuum tube. This book will be found to be largely based on these two conceptions. An elementary knowledge of electricity, such as that usually given in a first course in Physics, is assumed. Although I have endeavored to give a non-mathematical treatment of the subject, some Calculus has been introduced in a few sections. These mathematical sections have been developed and explained in a way which I hope will be helpful to the non-mathematical reader. The text has been illustrated by a large number of diagrams and pictures of radio apparatus."

Numerous references are given throughout the book and these add considerably to its completeness. *Fundamentals of Radio* is to be recommended.

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IMPROVING THE CLASS B AMPLIFIER

By D. E. REPLOGLE

PART II

CLASS B AUDIO amplification has of late achieved a very popular position in the minds of radio design engineers for the securing of high audio power output. However, I believe too many are under the impression that Class B amplification is magic—better than anything else yet achieved—without realizing its definite limitations as well as how to make the best use of its advantages. Class A at both audio and radio frequencies is still the ideal method of amplification for high fidelity and simplicity of design, if cost and power requirements can be ignored.

CLASS B STATUS

Class B amplification with its obvious disadvantages has, because of its low cost per watt output as compared with Class A, been able to outstrip the use of Class A for the same purpose. The fact that it has done so is to my mind a very definite tribute to design engineers who, forced by cost competition, have had to make the best out of what inherently was a difficult and poor method of securing large audio output. Such has been the case, however, and today, thanks to transformer-design engineers who have pioneered this difficult field—thanks to the circuit men of the tube manufacturers and to the skill of the transmitter design engineers—Class B audio amplification has taken its place for high quality and reliable performance right alongside of Class A operation.

The purpose of this article is to clarify the requirements for properly designed Class B output stages and to solve a specific problem which makes use of the new 930B tubes introduced on the market a year or more ago, but which have not been given the attention they deserve in the particular amplification field for which they were designed.

The 930B tube, around which is based the Class B amplifier design covered in this article.

Most of the material found in this article is not entirely new, but to review it and apply it to the use of these excellent tubes will undoubtedly be a help to the design engineer who intends to use them for this purpose.

There are three elements necessary for a satisfactory Class B set-up:

1. The use of proper circuits.
2. The all-important transformers—input and output.
3. Properly designed tubes for the purpose.

1—PROPER CIRCUITS

The circuit illustrated by Fig. 4 is indeed a simple one. The main considerations in this circuit are the plate and grid power supplies. Much has been said about the necessity of good regulation of plate power supplies. This is extremely important—an argument for this does not need to be repeated here.

Good regulation on the grid supply is as important as good filtering for high fidelity in Class B circuits. A study of tube characteristics you will have under Class B operating conditions shows plainly that the grid bias voltage must be held constant in order that the plate characteristics of the tube will be linear through the part of the cycle when the tube is working. The penalty for not securing exceptional regulation in the grid-bias supply is distortion due to the high harmonic content in the output.

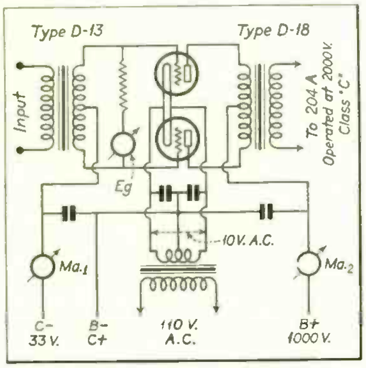

FIG. 4. CLASS B CIRCUIT REFERRED TO IN TEXT.

To anyone designing or building a Class B audio stage, this question of regulation in both plate and grid supplies cannot be emphasized too greatly—it is far better to err on the side of exceptionally good regulation than otherwise. Some of the most important features in a satisfactory power-supply unit for Class B stages can be summarized briefly here:

If a rectifier filter system is used these precautions should be observed: The final filter condenser should not be less than 8 mfd in the grid unit and the bleeder should be so low as to draw several hundred milliamperes. The transformer voltage can be low and it should have fairly good regulation to start with. The rectifier tube itself is very important—neither the 83 nor the 5Z3 tubes are good for two reasons: First, neither of them can supply the current peak demanded for a high-power audio system such as will be described and second, because both of these tubes have a much higher tube drop than is desirable and which can be secured by using other more satisfactory rectifiers.

Fortunately the type 866 rectifier is available and while it may seem a little large for the purposes required in this type of circuit, it is certainly best to use a tube of this type to take care of the peaks required. These tubes can be secured at a reasonable price and it is a wise designer who uses these tubes at the outset for his plate and grid voltage supply units.

The grid supply can be taken from batteries, of course, but here again the charging current through these batteries will vary the voltage and cause trouble. If they are to be used, provision should be made for cell-by-cell variation to maintain the bias constant at the proper setting.

Motor generators are satisfactory if one can overlook their high cost and maintenance. They must, of course, be used with an adequate filter which

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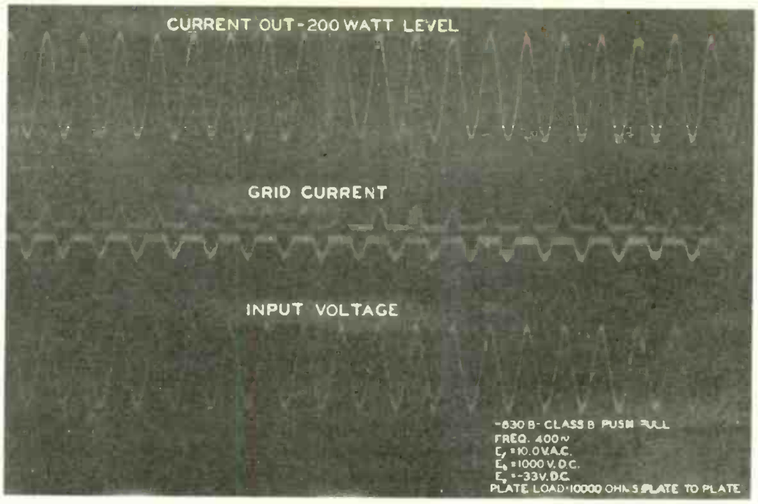

FIG. 5. OSCILLOGRAPHIC CURVES. 200-WATT LEVEL. USING CIRCUIT OF FIG. 4.

should be of a very similar design to that used with the conventional rectifier circuits.

2—CORRECT TRANSFORMERS

Here lies the heart of the Class B system. Almost everything depends upon the transformer design. Everyone is thinking and designing for high fidelity these days and many of them do not know what this means electrically, but they do know that it means faithful reproduction at the output of what is put in. Too often we stress the securing of a flat frequency response. Often this can be secured at low power levels where it is easy to measure, but even if the frequency response holds up fairly well at high power levels the fidelity of the system may be poor due to occurrence of harmonics. This accounts for what is sometimes considered a mysterious poor quality that is often secured from some transformers that show an excellent frequency response curve.

In a Class B audio transformer, the largest single source of distortion is usually the mismatching of impedance through an error of design or adjustment. Unfortunately we cannot see such an error in the technical data accompanying the transformer we buy, but if possible we should have the chance to check such transformers before actually putting them in service. Quite frequently transformers are sent out without individual calibration and the curves supplied are for the average of that type and may depart considerably from the curve of the individual transformer under consideration. Quite a number of other things may also enter into the situation. The transformer may be constructed of iron in which the characteristics are subject to change with sudden shock or jar, such as dropping on a concrete floor, and even the transformers when individually calibrated may be supplied with curves taken under conditions which do not correspond with those that are encountered in actual use. Many a good transformer under light loading will look good but when actually loaded to the peak as it would be in the circuit where it is to be used, shows an entirely different characteristic. Too often the winding of transformers has been badly bungled and has spoiled an otherwise excellent Class B stage and for this reason it is highly desirable to buy transformers put out by reputable manufacturers for use with tubes of given power outputs. The reputation of the manufacturer is your main reliance for correct performance of that transformer when used under conditions for which it was built.

INPUT TRANSFORMERS

The input transformer should preferably be for the Class A stage, and while it is a push-pull transformer, precautions should be taken that it is loaded by resistors having values between 50,000 and 100,000 ohms. Care should be taken that the preceding amplifier has enough gain to swing the grids under normal conditions. Two 210 tubes in push-pull Class A or two type 59s are very satisfactory for the driving stage. The 45s and 47s have too small a capacity to be satisfactory.

This loading will often cure some of the poor quality found in operating a Class B stage.

If a Class B input transformer is to be used for driving the 930B tubes, the same precautions that should be observed in the power Class B stage are important, namely:

Good regulation of the line load.

Proper excitation of grids.

Proper matching of transformers to output.

OUTPUT TRANSFORMERS

The output transformer is a more difficult task. It must combine the half-wave set to its primary from each of the two Class B tubes and from them build a complete waveform (see the oscillograms). Usually it is called on to do this with direct current flowing through its windings to a load such as a modulated Class C tube. It must also transfer the load impedance to some other value, which would be correct for the Class B tubes when working at a given level. It is readily appreciated that the iron of the core must go through many electrical gyrations not encountered in ordinary transformer design, so it is very necessary that the core be ample if flat response down to 30 cycles is wanted with an output of 200 watts. The transformer considered in this circuit can be used with 150 milliamperes of d-c flowing through the secondary. This would supply only 125 watts to a Class C r-f tube working at 1,000 volts.

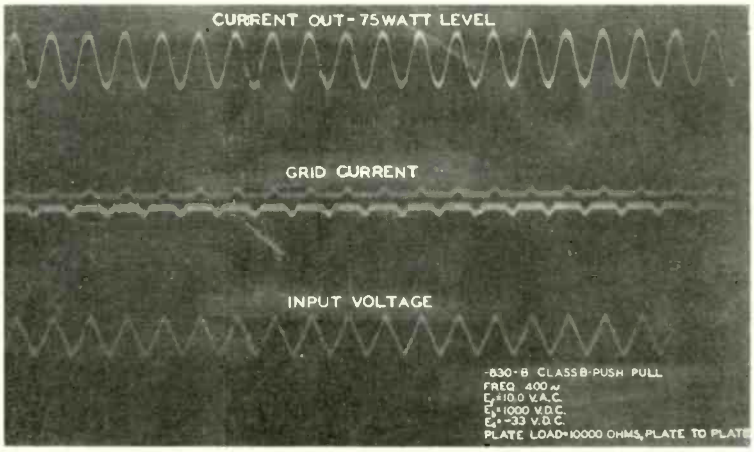

FIG. 6. OSCILLOGRAPHIC CURVES. 75-WATT LEVEL. USING CIRCUIT OF FIG. 4.

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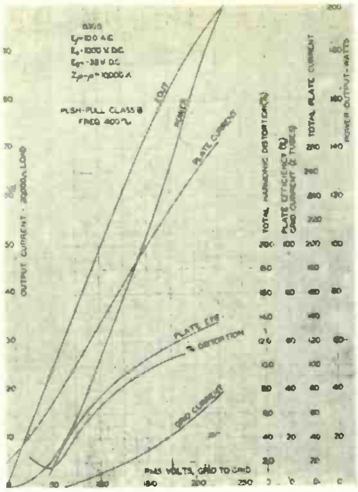

FIG. 7. CURVES SHOWING INPUT AND OUTPUT POWER, PLATE AND GRID CURRENT, PERCENTAGE DISTORTION AND PLATE EFFICIENCY.

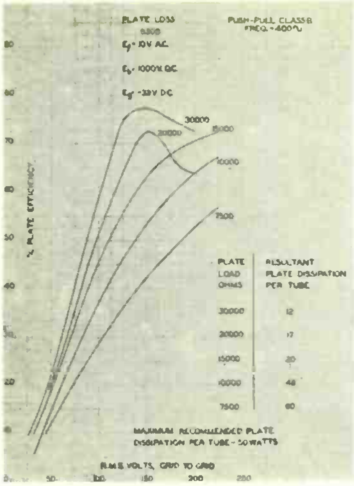

FIG. 8. CURVES SHOWING PLATE LOSS AND PLATE EFFICIENCY.

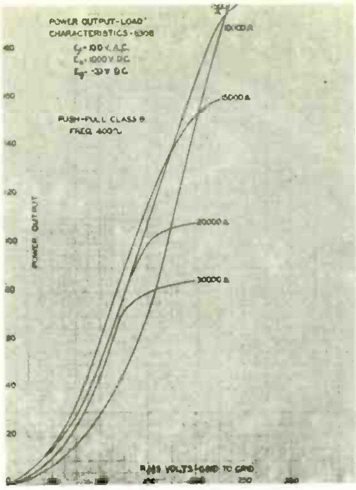

FIG. 9. CURVES SHOWING OUTPUT WITH VARYING PLATE IMPEDANCES.

Naturally we would like to increase the current of the 930Bs to something near 200 mils. It would seem as though we could then modulate 400 watts d-c with our 200 watts of audio. Unfortunately, this really can be done, but the possibility of the Class C tube being modulated in a linear manner is small. A much more satisfactory scheme is to assume that the 200 audio watts will probably modulate 300 watts d-c and the output transformer secondary need only carry 150 mils. True, a pair of 930B tubes can deliver the 200 audio watts. It is just not good practice to run a modulator wide open.

A very satisfactory design for Class B input and output transformers appears at the end of this article. These are the transformers used in obtaining the oscillographic curves of Figs. 5 and 6.

TUBE CHARACTERISTICS

The reasons why the 930B is an excellent Class B modulating tube are as follows:

1. It has high amplification factor.
2. It has more than ample filament emission.
3. It has moderate plate resistance to facilitate transformer construction.
4. It is a three-element tube and has no screen or suppressor grid voltages to worry about as in some of the pentode tubes, and, of course, it is simpler to utilize and will give better results with less effort.

ILLUSTRATIONS

Fig. 5 shows the actual oscillographic curves made with a G.E. multi-strength instrument of input voltage and output voltage at 400 cycles with an output level of 200 using the circuit shown in Fig. 4 and the transformers mentioned in this article.

The total percentage distortion at 200 watts may be as high as 11 percent but the quality is considered quite good for amateur work.

Fig. 6 shows the same tubes in the same circuit with a 75-watt level and at this level the harmonic distortion is approximately 4 percent which is better than most broadcast audio equipment.

Curves showing the power in, power out, plate current, grid current, percentage of distortion and plate efficiency are given in Fig. 7. The power output with various output load resistances for these tubes is also given in Fig. 7.

Plate loss and plate efficiency are given in Fig. 8.

Fig. 9 shows output with varying plate impedances.

Fig. 10 shows actual frequency response curve run under full-load conditions using 930B tubes in the circuit shown. It will be noted that this curve will do credit to most high-quality broadcast stations of today and shows the type of high-fidelity output which can be obtained with these tubes at 100 watts power.

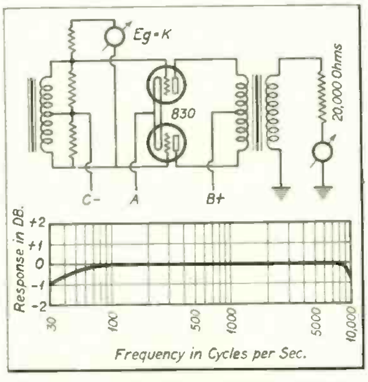

FIG. 10. FREQUENCY-RESPONSE CURVE—CLASS B MODULATION TRANSFORMER, 930B PUSH-PULL INTO 20,000-OHM LOAD; POWER, 100 WATTS.

From these curves very complete information can be had on the use of this tube in any Class B circuit.

ADJUSTMENT OF THE CLASS B STAGE

The meters of a Class B audio stage are not present for decorative purposes. They are essential in both adjustment and operation.

The use of the meters can best be shown by example. Let us therefore assume a 930B working at 1,000 volts plate and —33 volts grid bias, with a steady sinusoidal a-c input to the grid, sufficient to produce a 150-watt output from the pair. This requires (as the curves of Fig. 9 show) 200 volts rms on the grids—measured grid-to-grid between the two 930B tubes.

At this point the first meter enters in. We *must* be able to measure the a-c voltage applied to the Class B grids; otherwise, we are pawing around in the dark. Unlike Class A grid circuits, we are here dealing with moderate impedances, hence there is no harm in connecting a rectifier-type voltmeter across the circuit. It had best have a range of 0-300 volts. The meter calibrated as a volume indicator or as a modulation meter, the procedure being fairly obvious. In any case, make a red mark on the scale to show where the fidelity becomes unsatisfactory, as shown by a listening test made by a close observer.

From the conditions given the two Class B tubes should be "looking into" a 10,000-ohm load, as shown by Fig. 6. More precisely, they should be working into a transformer which is not only capable of combining their half-wave contributions into a whole-wave output but which also has the proper ratio of secondary to primary turns so that the

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actual secondary load *looks* like 10,000 ohms when seen from the primary side. Under these conditions (with the 200 volts of steady a-c still applied to the grids) the meter Ma1 (Fig. 4) should read 30 ma for the two grids together, and the meter Ma2 should read 260 ma for the two plates together. These values are taken from Fig. 7.

Suppose that instead we have the tubes looking into an excessive impedance, for example—20,000 ohms. With the same driving voltage the grid current will now be 50 ma and the plate current 165 ma. *Whenever the impedance of the load is too high, through error in either the transformer or the load, the plate currents will be too low, the grid current too high, as judged by the curves of Fig. 7.* Without such curves it is difficult to know how proper adjustment is to be made. The information here given for the 930B makes the job easy in that case.

On the other hand, suppose that the tubes "see" only 7,500 ohms, because either the load or the transformer is wrong. We now find that the grid meter Ma1 reads but 25 ma while the plate supply meter Ma2 reads 270 ma. This gives us Rule No. 2. *Whenever the load seen by the tubes has too low an impedance through error in either load or output transformer, the plate supply current will be higher and the rectified grid current lower than the proper values shown in the curves of Fig. 7.*

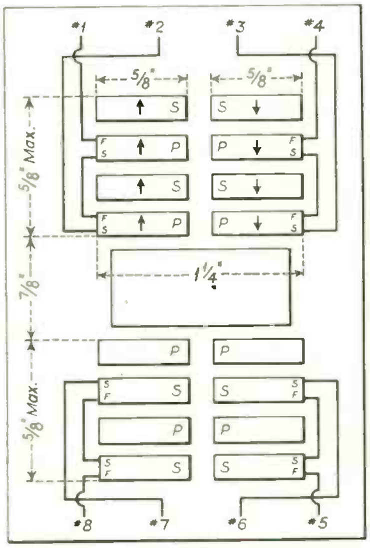

Fig. 11. Winding Form: 7/8" x 1 1/4". Core Insulation: One layer .015" Armite; four layers .005" Gum Kraft, cut 1 1/4" wide. Primary and Secondary Windings: Four 750-turn coils, No. 34E, split-wound, series connected, center taps; wind 63 turns per layer, 12 layers per coil. Interwinding Insulation: One layer .0015" Glassine paper, cut 5/8" wide. Primary-Secondary Insulation: One layer .01" Micanite, two layers .005" Gum Kraft, cut 1 1/4" wide. Outside Insulation: Five layers .005" Gum Kraft, cut 1 1/4" wide. Leads: No. 24 Candid, 6" long.

OUTPUT POWER AND OVERLOAD

Unfortunately there is no such positive and simple indication of overload as is found in Class A work. Furthermore, we are not assured of any particular output power just because we know the grid swing, as shown by the grid voltmeter.

The tests given above enable us to make proper impedance adjustments with a steady input tone, but no longer apply directly when we are using an unsteady sound like speech or music.

Violent leaps of the grid-current meter are suspicious, as is a failure of the plate meter to rise when spoken to. These facts may be used to locate overload for transient sounds. Speaking at an even level, advance the gain control slowly. The grid and plate meters obediently start upward and for a time continue to rise fairly evenly. Quite suddenly the plate meter hesitates, and at the same moment the grid meter becomes excited, and advances rapidly or jumps, depending somewhat on the speech used. This is definitely an overload condition, back down until it disappears.

If the load impedance is too high the effect just mentioned appears early in this rough test, exactly as one would judge from Fig. 6, which shows the impossibility of putting much power into a high-impedance load.

TRANSFORMER DATA

In regard to the audio input and output transformers mentioned above, much could be said about transformer design. This data is given simply for information on a typical transformer which has been built and given the results mentioned above.

INPUT TRANSFORMER D-13

Core Data:

Material—Alleghany Dynamo Special 25 B&S Gauge.

Laminations—LE-2 stacked 1¼ inch thick and interleaved. This core is held together with No. 6-32 x 1¾ inch brass bolts on each corner and in the center. (See Fig. 11).

The windings of this transformer are rather unique and real effort has been successfully made to reduce the leakage reactance and distributed capacity to a minimum—it being readily realized that these two factors caused most of the distortion in transformer design. To secure this result, the primary and secondary have been interleaved and the transformer coils have been wound in two layers as shown in the sketch. Notes on wire sizes, method of winding, method of insulation are given on the sketch.

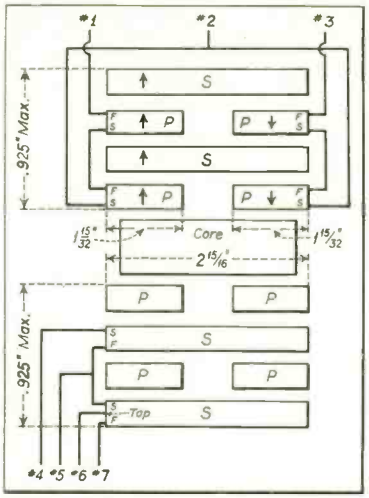

Fig. 12. Winding Form: 1½" x 2¼". Core Insulation: One layer .015" Armite, one layer .01" Micanite, two layers .005" Gum Kraft, cut 2-15/16" wide. Primary Winding: Four 835-turn coils, No. 30E, split-wound, series connected, center taps; wind 104 turns per layer, 8 layers per coil. Secondary Winding: Two 2360-turn coils, No. 29E, series connected, bottom coil tapped at end, top coil tapped at 980 turns from start. Interwinding Insulation: One layer .0015" Glassine, cut 1-15/32" wide. Primary-Secondary Insulation: One layer .01" Micanite, one layer .005" Gum Kraft, cut 2-15/16" wide. Outside Insulation: Two layers .01" Micanite, two layers .005" Gum Kraft, cut 2-15/16" wide. Leads: No. 24 Candid, 6" long.

The coils should be baked two hours at a temperature of from 180° to 200° F, and they should then be dipped while hot into a heated beeswax compound and boiled to remove air pockets. Let the coil cool to room temperature and again dip in heated beeswax compound and cool.

Laminations are then stacked in the coil. Bolt and clamp laminations at the four corners, using a stiff metal packing across the two ends of the transformer. Any appropriate transformer case can be used, or terminals of the transformer can be brought to an insulated board held on the core clamp bolts. The whole transformer should then be dipped in an insulation compound to hold the laminations in place and prevent moisture from entering the windings. (Mitchell-Rand Compound No. 2438).

OUTPUT TRANSFORMER D-18

Notes on the winding are given in Fig. 12. Preparation of the coil is the same as that for the input transformer D-13.

While the above transformer data may be somewhat complicated; the exceptionally fine audio response curve, however, is a result of these complications and where needed, the work involved will be justified wherever these transformers are used.

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Impedance Matching

By T. W. KILMER, JR.

In practically all types of communications circuits one is confronted with the problem of connecting a circuit of one impedance to a circuit of a different impedance. The most advantageous method of accomplishing this is often left to the discretion of the engineer on the job. Certain circuits must be coupled in a ridgidly prescribed manner, while others may be coupled in a variety of ways.

REASONS FOR IMPEDANCE MATCHING

There are two important reasons why impedances should be properly matched. The first is a matter of maximum power transfer. In Fig. 1a a generator of emf, E, and internal resistance R_G is feeding power to the load resistance R_L. The current flowing in the circuit is given by,

$$I = \frac{E}{R_G + R_L}$$

The power in the load resistance is,

$$I^2 R_L = \frac{E R_L}{(R_G + R_L)^2} \qquad (1)$$

If equation (1) is differentiated with respect to R_L and then maximized, it can be shown that the maximum power transfer is obtained when $R_G = R_L$. This same procedure can be extended to the general case of Fig. 1b, where R_G and R_L are replaced by the impedances Z_G and Z_L. In this case the maximum power transfer occurs when Z_G and Z_L are conjugates. That is, when $X_G = -X_L$. If the phase angle is fixed, the maximum power transfer takes place when the magnitudes of Z_G and Z_L are equal.

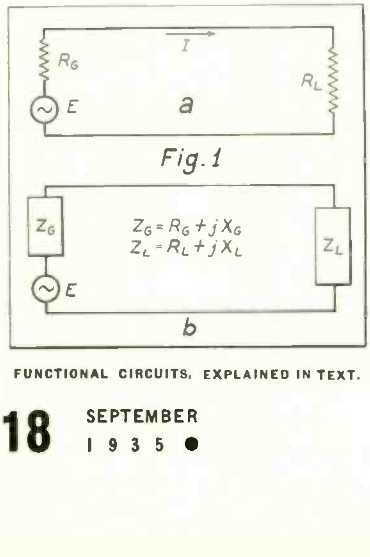

Fig. 1

FUNCTIONAL CIRCUITS, EXPLAINED IN TEXT.

When the sending and receiving impedances are not equal, a loss takes place due to reflection. This reflection loss will be discussed later in more detail.

The second reason why impedances should be matched is that many communication circuits will not function properly if they do not work into correct impedances. Thus if an amplifier designed to work into an impedance of 500 ohms, is connected to an impedance of 75 ohms, it will not have the proper load coupled into its plate circuit. This will usually cause distortion, and in some cases overloading. In this case it is necessary to match the output impedance of the amplifier to the load to which it is to be connected. This process may introduce considerable loss which will be tolerated only because distortion has been avoided. Many communication circuits such as mixers, telephone lines, speaker systems, etc., require impedance matching for their proper operation. In most cases the impedances to be matched can, for engineering purposes, be considered as pure resistances. This assumption greatly simplifies the calculations and matching circuits.

RESISTIVE NETWORKS

There have been numerous articles in the current literature covering resistive networks very completely*. Therefore only the essential elements necessary for impedance matching will be discussed here. Resistive networks make good impedance-matching devices provided that a loss can be tolerated in that part of the circuit. They are inexpensive, and can usually be built quickly from spare parts. They have a flat frequency response which is an advantage for most work.

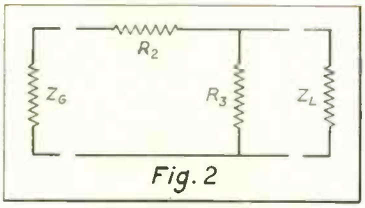

Fig. 2

L-TYPE RESISTANCE NETWORK.

The L-type network, shown in Fig. 2, is about the simplest and cheapest method of matching two impedances. With the correct values of R_2 and R_3, the generator impedance and load impedance both see impedances equal to their own. Thus, there is no reflection loss. The series resistor R_2 should point toward the largest terminal impedance.

If we assume that the terminal impedances Z_G and Z_L are both pure resistances, then,

$$R_2 = \sqrt{Z_G (Z_G - Z_L)} \qquad (2)$$

$$R_3 = \frac{Z_G Z_L}{\sqrt{Z_G (Z_G - Z_L)}} \qquad (3)$$

The insertion loss introduced by this network can be calculated from,

$$K = \sqrt{\frac{Z_G}{Z_L}} + \sqrt{\frac{Z_G}{Z_L} - 1} \qquad (4)$$

Where the loss in db is given by,

$$\text{Loss in db} = 20 \log_{10} K \qquad (4')$$

An inspection of equation (4) shows that the insertion loss for an impedance-matching network of this type is a function of the terminal impedances. Thus, once these values are fixed, the loss is also fixed for a correct match. L-type networks may be used as attenuators with practically any desired insertion loss, but in this case the impedance match is in one direction only.

T —, H —, O —, and π — type, both balanced and unbalanced, resistive networks give a controllable insertion loss and impedance match in both directions. The design of these types is fully covered in the references given in the footnote.

EXAMPLE

It is desired to connect an amplifier whose load impedance is 5000 ohms to a speaker system whose impedance is 50 ohms. (Fig. 3a).

*The Design of Pads—L. W. Barnett—COMMUNICATION AND BROADCAST ENGINEERING, Feb. 1935.
The Design of Resistance Pads—C. F. Nordica—*Radio Engineering*, Dec. 1934.
Designing Resistive Attenuating Networks—P. K. McElroy—Proc. I.R.E., Mar. 1935.

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AT AUDIO FREQUENCIES

From equations (2) and (3)

$$R_2 = \sqrt{5000\ (5000 - 50)} = 4975 \text{ ohms}$$

$$R_3 = \frac{5000 \times 50}{\sqrt{5000\ (5000 - 50)}} = 50.25 \text{ ohms}$$

The insertion loss of such a network is, from equations (4) and (4'),

Loss in db = 20 Log_{10}

$$\left[\sqrt{\frac{5000}{50}} + \sqrt{\frac{5000}{50} - 1}\right] = 26 \text{ db}$$

Fig. 3a then becomes 3b.

That an impedance match does exist in this circuit is proven as follows,

Let Z_1 = Impedance to right of A-B (Fig. 3a)
Let Z_2 = Impedance to left of C-D (Fig. 3a)

Then,

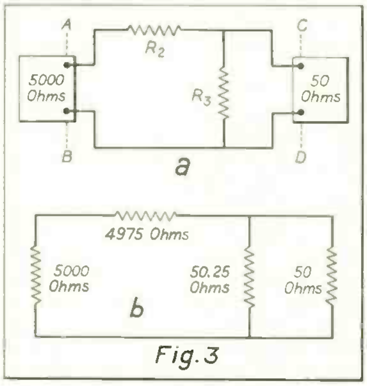
$$Z_1 = 4975 + \frac{50.25 \times 50}{50.25 + 50} = 5000.1 \text{ ohms}$$

$$Z_2 = \frac{50.25\ (4975 + 5000)}{4975 + 50.25 + 50} = 50.0 \text{ ohms}$$

TRANSFORMERS

Another method of matching impedances is by the use of transformers. This method has certain advantages over the resistive networks which will become apparent as the discussion continues. There are also disadvantages, such as higher cost and limited frequency range over which the impedance match holds.

In Fig. 4a, a generator G with internal impedance Z_G, is connected to the load impedance Z_L through the transformer,



TYPICAL CIRCUIT REQUIREMENT AND ITS SOLUTION. SEE TEXT.

R_P = Resistance of primary winding
R_S = Resistance of secondary winding
I_P = Primary current
I_S = Secondary current
L_P = Inductance of primary winding
L_S = Inductance of secondary winding
M = Mutual inductance of primary and secondary
N_P = Number of turns on primary
N_S = Number of turns on secondary

For the purpose of this analysis it is sufficient to assume Z_G and Z_L to be pure resistances. The power in the primary circuit is then

$$I_P^2\ (Z_G + R_P)$$

the power in the secondary circuit is

$$I_S^2\ (Z_L + R_S)\ .$$

As the efficiency of a good transformer is very high, we have,

$$I_P^2\ (Z_G + R_P) = I_S^2\ (Z_L + R_S)$$

$$\frac{I_P^2}{I_S^2} = \frac{Z_L + R_S}{Z_G + R_P}$$

If we assume

$$R_S << Z_L \text{ and } R_P << Z_G\ ,$$

then.

$$\frac{I_P^2}{I_S^2} = \frac{Z_L}{Z_G}$$

But

$$\frac{I_P^2}{I_S^2} = \left(\frac{N_S}{N_P}\right)^2$$

Therefore,

$$\frac{Z_L}{Z_G} = \left(\frac{N_S}{N_P}\right)^2 \qquad (5)$$

It can be shown that a transformer circuit, such as that of Fig. 4a, can be replaced by the equivalent T-network of Fig. 4b. Here R_S and Z_L have been replaced by their equivalents. The inductances $(1\text{-}K')L_P$ represent the leakage inductances of the primary and secondary windings.

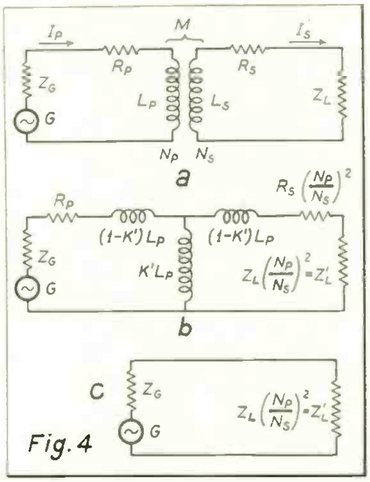
If $K' = 1$, and

$R_S << Z_L << \omega L_S$, and $R_P << Z_G << \omega L_P$,

then Fig. 4b may be replaced by the circuit of Fig. 4c. From equation (5)

$$Z_G = Z_L \left(\frac{N_P}{N_S}\right)^2 = Z_L'$$

Thus there is a match between the sending and receiving impedances. Furthermore, the loss accompanying the match is negligible. Instead of using a resistive network in the previous example, a transformer with the following turns ratio could have been used.



TRANSFORMER-COUPLED CIRCUIT AND ITS EQUIVALENTS.

From equation (5),

$$\frac{Z_G}{Z_L} = \frac{5000}{50} = \left(\frac{N_P}{N_S}\right)^2$$

$$\frac{N_P}{N_S} = \sqrt{100} = 10$$

$$N_P = 10\ N_S$$

A transformer with a turns ratio of 10:1 will match these two impedances provided the following two conditions are approximately fulfilled: These conditions are perfectly general and apply for any other two impedances being matched.

$$X_M = \sqrt{X_P\ X_S} \qquad (6)$$

or $K' = 1$

X_P = Primary reactance
X_S = Secondary reactance
X_M = Mutual reactance
K' = Coefficient of coupling

and,

$$X_M >> \sqrt{Z_G\ Z_L} \qquad (7)$$

If the impedances to be matched are large, the relation 7 will not be approximated, unless the mutual reactance of the transformer is also large. This means a liberal use of core material and plenty of turns. When matching low impedances, the resistance of the transformer windings should be kept very low, otherwise R_P and R_S cannot be

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neglected and the circuit of Fig. 4c will not be realized. With a given transformer, the range of impedances which can be matched is limited. That the square of the turns ratio should equal the impedance ratio is not the only requirement. Relations 6 and 7, together with the above mentioned restrictions, must also apply. When matching impedances, there is no equality between the terminal impedances and the impedances of the transformer windings. The requirement is that the impedances of the windings should be large compared to the terminal impedances.

The frequency range over which an impedance match holds is limited. At low frequencies the mutual reactance decreases and, therefore, relation 7 does not hold true. At high frequencies the leakage reactance increases and the internal capacity of the windings causes trouble. The frequency range of a transformer can be extended over the entire audio spectrum provided that ideal conditions are closely approximated.

IDEAL TRANSFORMER

An ideal transformer would have a linear frequency response. and would have the following characteristics:

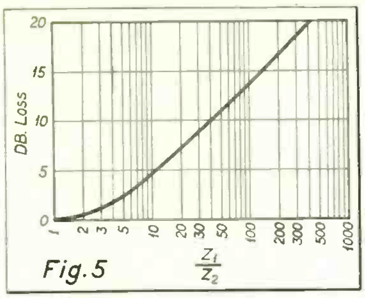
1. R_P and R_S equal to zero.
2. Finite ratio of primary to secondary inductance, but infinite primary and secondary inductance.
3. Coefficient of coupling. K', equal to unity.
4. No internal capacity.

Such characteristics can be approximated to a very high degree in a well designed audio transformer. Number 1 is approximated if R_P and R_S are small compared to Z_G and Z_L. Number 2 can be satisfied for all practical purposes if

$$\omega M >> \sqrt{Z_G Z_L}.$$

This is obtained by using a large number of turns of wire wound on a core made of high permeability material. Number 3 is closely approximated if a high permeability core is used and the windings so placed that practically all the flux from one coil links that of the other coil. Number 4 can be approximated, but not as closely as the others, by proper arrangement of the windings and leads.

Transformers with these characteristics, and suitable for a wide range of audio frequencies can be obtained from reliable manufacturers. There are many transformers on the market intended for audio-frequency circuits which do not meet these requirements. Therefore, care should be exercised in selecting transformers for audio-frequency circuits. The use of a poorly designed transformer can ruin the operation of an otherwise well designed circuit.



IMPEDANCE RATIOS PLOTTED AGAINST DB LOSS.

REFLECTION LOSS

When two circuits of different impedances are coupled together directly, a loss occurs which is proportional to the impedance mismatch. This is known as reflection loss. If the loss can be tolerated, and if distortion is not a factor to be considered, then no impedance matching is necessary. In communication work, usually distortion cannot be permitted, and impedance matching must be accomplished. The reflection loss can be calculated as follows.

$$\text{Loss in db} = 20 \text{ Log}_{10} K_1 \qquad (8)$$

Where K_1 is the ratio of the current which would flow if the impedances were properly matched to the current which is actually flowing.

Let. I_1 = Current which would flow with proper match.
I_2 = Current actually flowing.

Referring to Fig. 1b, we have,

$$I_1 = \frac{E}{2 Z_G}\sqrt{\frac{Z_G}{Z_L}} = \frac{E}{\sqrt{4 Z_G Z_L}}$$

Where,

$$\sqrt{\frac{Z_G}{Z_L}} = \frac{N_P}{N_S} = \text{Ratio of transformer necessary to accomplish impedance match.}$$

$$I_2 = \frac{E}{Z_G + Z_L}$$

and

$$K_1 = \frac{I_1}{I_2} = \frac{Z_G + Z_L}{\sqrt{4 Z_G Z_L}} \qquad (9)$$

Fig. 5 is plotted from equation (8) for impedance ratios from 1 to 1000. Z_1 and Z_2 are the terminal impedances, whose ratio is kept greater than unity by placing the one with largest magnitude in the numerator.

If in the example given above, the amplifier had been connected directly to the speaker system. the reflection loss would be,

$$\text{Loss in db} = 20 \text{ Log}_{10}\left(\frac{5000 + 50}{\sqrt{4 \times 5000 \times 50}}\right) = 14 \text{ db.}$$

When these two circuits are connected by a resistive network, a loss of 26 db results. In this case the amplifier would operate with the correct load, and no distortion would result. The price paid for this quality is $26 - 14 = 12$ db. Were the amplifier and speaker connected through a good matching transformer, the distortion would be eliminated and practically no loss introduced in the circuit.

Resistive networks can be used for impedance matching provided the loss they introduce can be tolerated. The problem of deciding between resistive networks and transformers for impedance matching is largely economic and should be solved by the individual to fit his needs.

BROADCASTING DEVELOPMENTS IN SOUTH AFRICA

BROADCASTING DEVELOPMENTS in South Africa over the past year have been extensive. The decision to remove broadcasting from private control and set up an organization similar to that under which the service is conducted in Great Britain is the outstanding development.

Under the African Broadcasting Company the number of licensed listeners have increased from 17,000, four years ago, to over 100,000, at the present time.

Broadcasting studios with modern equipment have recently been put into service at Capetown and Durban, and Johannesburg has under construction in its new "Broadcast House," the most ambitious radio building in Africa. It is 8 stories high with 13 studios, all with the most modern layout. Telephone lines connect the building with all the important entertainment places in the city.

The buoyant economic situation in South Africa, particularly at Johannesburg and vicinity, owing to the high price of gold, resulted in a greatly increased demand for radio equipment and receivers, of which American manufacturers enjoyed a large share. (Commercial Attache Samuel H. Day, Johannesburg, in *Electrical Foreign Trade Notes.*)

TELEVISION IN THE UNITED KINGDOM

IN THE HOUSE of Commons it was stated that, although no date could be announced when the broadcast of television might begin the "Baird Television Company and the Marconi M. E. I. Television Company have been invited to tender for the supply of the necessary apparatus for the operation of their respective systems" at the station which had been chosen at the Alexandra Palace. It was also stated that the Television Advisory Committee have satisfied themselves that receivers can be constructed capable of receiving both sets of transmissions without unduly complicated or expensive adjustment. (Counselor of Embassy Ray Atherton, London, *Electrical Foreign Trade Notes.*)

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A Crystal Superheterodyne

A Fixed-Tune Police Receiver with Crystal Stabilized Conversion Oscillator

By G. F. LAMPKIN
LAMPKIN LABORATORIES
Bradenton, Florida

EXPERIENCE OVER a number of years with tuned radio-frequency receivers in police mobile use has pointed the way towards a new set design with major improvements. There are several radio services in which a fixed-tune receiver is necessary; and which, in addition, require that the receiver operate without attention for extended periods of time.

Notable among such services is police radio, embodying a multiplicity of receiving units in fixed locations and in vehicles, all tuned to one central transmitter. Other services, such as aircraft and aeronautical, point-to-point telegraph and telephone, etc., might be mentioned as examples.

LACK OF STABILITY

The full advantages of the superheterodyne method of reception cannot generally be realized in such applications. It will be found that a receiver designed and adjusted for a high order of selectivity will not stay on tune. The distortion that can be caused by a selective receiver, when slightly off tune, is tremendous; and the better the selectivity the worse will be the reception when peaked off the edge of the channel. For this reason it has been customary to use tuned radio-frequency sets in services where the requirements are exacting. Such superheterodynes as have been used have of necessity been broadly tuned, with characteristics but slightly better than those of a good tuned r-f set.

THE CURE

A partial cure can be found in the use of air-tuned intermediate-frequency transformers. It will be partial only, since as a rule the chief source of drift is in the conversion oscillator. An obvious remedy is to stabilize the conversion oscillator by means of a quartz crystal.

Crystal superheterodyne receivers of the type to be described have been built and installed on mobile units by the radio engineering force of the Cincinnati police department. Previous to production on the receivers, an original design model operated over 14 months in actual, continuous, police service on a patrol wagon without requiring attention of any sort. It ran up a record which had not terminated at the time of observation.

FEATURES

Salient features of the crystal superheterodyne, some of them more particularly applicable to police mobile use, include a very high order of selectivity. The entire receiver can be very sharply peaked on the station frequency and it will hold the adjustments indefinitely. The use of the quartz crystal conversion oscillator is directly responsible, and, to a lesser degree, the inclusion of high-grade circuit parts. An immediate result is the appreciable reduction in apparent noise level. In a large city there are numerous locations, such as along busy streets and under car lines, where a patrolman must develop "tin ears" in order to stand the racket issuing from the loudspeaker. In such locations the difference between the noise outputs of a crystal superheterodyne and an equally sensitive tuned r-f set is not a small quantity detectable on measuring instruments. It is at once apparent to any listener.

In addition to noise reduction, the increased selectivity tends toward elimination of crosstalk from the adjacent police channels. Crosstalk from police stations other than the local, but operating on the same assigned frequency, is, of course, inevitable; but that which can be heard on some older types of receivers from stations two or three channels removed, and which can be particularly bothersome at night, is susceptible to discrimination. Since the separation between some of the police channels is 6 or 8 kilocycles, an even higher order of selectivity than that for the broadcast channels can be utilized.

GREATER SELECTIVITY AND SENSITIVITY

Along with increased selectivity, greater sensitivity using smaller overall dimensions results with the superheterodyne, as against the tuned r-f set. The shielding and circuit filtering requirements are not so critical. With the modern multipurpose tubes adapted to superheterodyne circuits a compact layout is secured. Because of the inherent noise reduction, the generally higher sensitivity of the crystal superhetero-

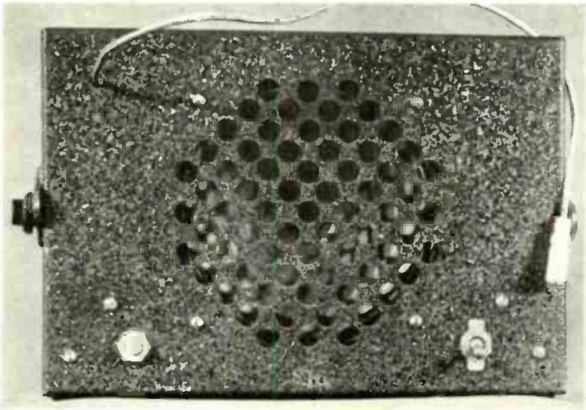

FIG. 1. FRONT VIEW OF THE CRYSTAL SUPERHETERODYNE POLICE RECEIVER.

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dyne is not so apparent in actual operation until weak-signal reception is attempted. The betterment in signal-to-noise ratio is then obvious.

Automatic volume control is of course included in the design, and an adjustable sensitivity control functions to cut the pickup to only that required for a given location. The complete equipment—chassis, speaker, and controls, excepting the eliminator—is housed in one container, as shown in Fig. 1. The overall dimensions of the complete unit are 6¾ by 7¼ by 12 inches.

LOCATION OF RECEIVER

The small dimensions of the receiver permit its installation in a variety of locations in a car; the usual preference being under the dash, or, in a coupe, just behind the driver's seat. There is only one connection to be made or broken. It brings in the antenna and the power supply wires. To one who has worked on older installations, this modern version presents about the ideal in convenience.

The installation and maintenance are much simplified, and the probability of service failures due to extended wiring and parts is lessened. A vibrator-type eliminator supplies plate power for the set. It is separated from the receiver, usually by the car bulkhead, in order to mitigate the radio-frequency disturbances sometimes set up by the power source after aging.

THE CIRCUIT

In Fig. 2 is drawn the schematic diagram for the crystal superheterodyne. Five tubes are used, lined up in the following function: 6D6 radio-frequency amplifier; 6A7 crystal oscillator and conversion detector; 6D6 intermediate-frequency amplifier; 75 diode detector, automatic volume control, and audio amplifier; and 41 pentode output tube. Save for the crystal oscillator, the layout is more or less conventional.

X-CUT CRYSTAL

For a signal frequency of 1706 kc, the crystal is ground to a frequency of 1881 kc, which allows the utilization of standard 175-kc intermediate-frequency transformers. The crystal is of the X-cut type, and is operated without temperature control. The tolerance on the crystal frequency is ± 5 kc. Since the conversion-oscillator frequency is inflexible, final tuning and lining up must all be done on the intermediate-frequency transformers.

The crystal is mounted in a small, compact holder with its major surfaces vertical. A slight spring pressure is exerted on the holder electrodes. The crystal oscillator tank coil, connected in grid No. 2 of the 6A7 tube, is so proportioned as to self-resonate for oscillation, and to obviate an extra variable tuning condenser. Complete stability of the conversion oscillator, not only as to frequency, but also as to continuity of oscillation, has been attained—and it makes possible the application of best superheterodyne performance to exacting fixed-tune problems.

VOLUME CONTROL

Experience has shown that in police work the volume control is seldom touched, but is left at one setting—the maximum, to preclude missing of calls. This fact, coupled with a set design which has both automatic volume control and a sensitivity adjustment, indicates that the manual volume control can be mounted directly on the receiver. There is then no extended electrical or mechanical-control unit on the steering post or dash. The manual volume control and the on-off switch are accessible at the set for the occasional necessary manipulation.

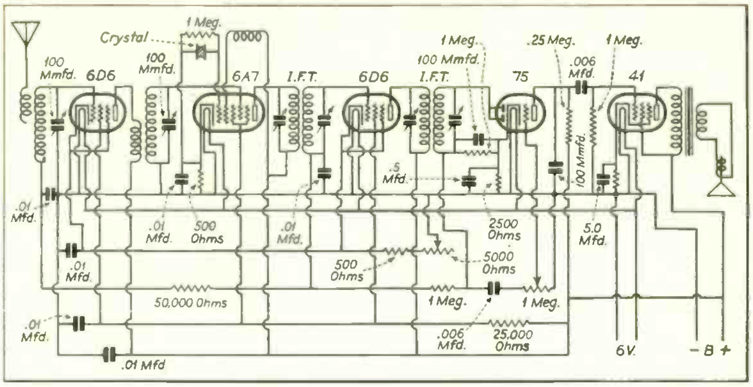

FIG. 2. CIRCUIT OF THE FIXED-TUNE CRYSTAL SUPERHETERODYNE.

CAR-BATTERY DRAIN

Perhaps one of the most important points in police mobile receivers is the magnitude of the drain on the car battery. It is important chiefly to the extent that the receiver is in continuous service. Of course, other factors, such as car running time, speed of operation, other demands on the battery, etc., have a part in determining if, and how much, battery recharging or replacement will be experienced. But, when averaged over all kinds of conditions, the lower the battery drain the lower will be the outage time and service cost figures for both radio and car. Often the battery maintenance figures do not appear as a radio item, since the work is handled outside the radio department by a garage or ignition shop.

The total measured drain of the crystal superheterodyne on a 6-volt battery is 2.6 amperes, using a dynamic speaker with permanent-magnet field.

TO FIGHT IONOSPHERE WITH 200 KW

A NEW APPROACH to the transmission of short-wave radio-telegraph signals over long distances will be tried by RCA this Fall on the completion of a new 200-kilowatt short-wave transmitter now under construction at the company's station at Rocky Point, Long Island.

By means of this tremendous short-wave power, which is 5 to 10 times the intensity usually employed in international communication, it is proposed to "battle the ionosphere with kilowatts" and override certain natural obstacles which to date have limited the signal strength under abnormal conditions.

What the engineers expect to determine by means of the new 200-kilowatt transmitter is whether the hours of usefulness of one or more of the wavebands used in long-range communication may not be lengthened and the effects of magnetic storms minimized by the use of increased power.

The new transmitter will be operated at first only on one wavelength, in the neighborhood of 28 meters. This wave has been selected as the trial one which promises the greatest general serviceability. It is expected that when radio signals from this transmitter are hurled against the ionosphere the greater power will cause them to be reflected back even during less favorable hours of operation for that particular wavelength. Present-day commercial radio practice has been brought to a high degree of reliability by directive transmission and through the use of the diversity system of reception.

The new transmitter will be immediately available on completion for commercial use in multiplex radio-telegraph transmission and facsimile transmission. It may ultimately be adapted to the transmission of addressed programs of voice and music to foreign countries.

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TELECOMMUNICATION

PANORAMA OF PROGRESS IN THE FIELDS OF COMMUNICATION AND BROADCASTING

STANDARD FREQUENCY SERVICE BROADCAST BY NATIONAL BUREAU OF STANDARDS

THE NATIONAL Bureau of Standards provides a standard frequency service which is broadcast by radio. Beginning Oct. 1, 1935, this service is given on three days each week, from the Bureau's station WWV, Beltsville, Md., near Washington, D. C. These radio emissions provide a standard for scientific or other measurements requiring an accurate radio or audio frequency or time rate, and are useful to radio transmitting stations for adjusting their transmitters to exact frequency, and to the public generally for calibrating frequency standards.

On each Tuesday and Friday the emissions are continuous unmodulated waves (cw); and on each Wednesday they are modulated by an audio frequency. The audio frequency is in general 1,000 cycles per second. (There are no emissions on legal holidays).

On all emissions three radio carrier frequencies are transmitted as follows: noon to 1 P.M., Eastern Standard Time, 15,000 kc; 1:15 to 2:15 P.M., 10,000 kc; 2:30 to 3:30 P.M., 5,000 kc.

The emissions on 5,000 kc are particularly useful at distances within a few hundred miles from Washington, those on 10,000 kc are useful for the rest of the United States, and those on 15,000 kc are useful in the western half of the United States and to some extent in other parts of the world.

FREQUENCY ANNOUNCEMENTS

During the first five minutes of the one-hour emission on each carrier frequency, announcements are given. For the cw emissions, the announcements are made by telegraphic keying and consist of the station call letters (WWV) and a statement of the frequency; this announcement is repeated every ten minutes. For the modulated emissions, the announcements are given only at the beginning of the hour; they are given by voice and include the station call letters and a statement of the carrier frequency and the audio modulation frequency.

Except during the announcements, the cw emissions consist of continuous, unkeyed carrier frequency, giving a continuous beat note in the telephone receiver in heterodyne reception. The radiated power in the cw emissions is 20 kilowatts.

The modulated emissions, except during the voice announcements at the beginning of the hour, consist of an uninterrupted audio frequency superposed on the carrier frequency. The radiated power is only one kilowatt; reception is therefore not as reliable as for the cw emissions of Tuesdays and Fridays; it is hoped to increase the power later. The modulated emissions are somewhat experimental, and for this reason an audio frequency other than 1,000 cycles per second may be used on some occasions. The presence of the audio modulation frequency does not impair the use of the carrier frequency as a standard to the same high accuracy as in the cw emissions.

ACCURACY OF TRANSMISSIONS

The accuracy of the frequencies as sent out from the transmitting station is at all times better than a part in five million. Transmission effects in the medium (Doppler effect, fading, etc.) sometimes result in slight fluctuations in the frequency as received at a particular place. However, these practically never impair the reception of the carrier frequency to the accuracy stated. Under some conditions, momentary fluctuations as great as 1 cycle per second may occur in the modulation frequency. It is generally possible, however, to use the modulation frequency with an accuracy better than a part in a million by selecting that one of the three carrier frequencies which has the least fading. It is helpful to use automatic volume control on the audio frequency.

Information on how to receive and utilize the standard frequency service is given in a pamphlet obtainable on request addressed to the National Bureau of Standards, Washington, D. C. From any single frequency, using harmonic methods, any frequency may be checked.

The Bureau welcomes reports of use and comments upon the standard frequency service. As the modulated emissions are somewhat experimental it is particularly desired that users report to the Bureau their experience in using them, including: description of method of use; statement of relative fading, intensity, etc., on the three carrier frequencies; and preference as to audio frequency to be furnished. Correspondence should be addressed National Bureau of Standards, Washington, D. C.

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NEW COLOMBIAN SHORT-WAVE BROADCASTER

The Ministry of Posts and Telegraphs has authorized the Municipality of Medellin, Colombia, to install a commercial short-wave radio broadcasting station with a power up to 300 watts in the antenna circuit. The station will operate on a frequency of 49.50 meters and will be identified by the call letters HJ4-ABD. (*Commercial Attache Clarence C. Brooks, Bogota, May 17, 1935*).

RADIO ROOM ABOARD THE NORMANDIE. SOUNDPROOFING WAS ACCOMPLISHED BY SPECIAL PAINT SPRAYING.
(Courtesy The DeVilbiss Co.)

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FEDERAL COMMUNICATIONS COMMISSION REPORTS

THE ULTRA-HIGH-FREQUENCY ALLOCATION PROBLEM

THE COMMISSION has endeavored during the past three or four years to obtain all available data on the transmission characteristics of the very high frequencies above 30,000 kilocycles and their possible application for radio communication in various radio services. This material will be needed when the time is at hand to allocate the ultra-high frequencies to various services for commercial use. Considerable information has been obtained from various sources, including the progress reports submitted by the licensees of experimental stations, the laboratories of commercial manufacturing and communication companies, Government departments, and technical papers which have appeared from time to time in the technical literature. The data at hand are still believed to be insufficient to permit an equitable distribution of the frequencies to radio services for commercial use at this time.

Although the physical properties of the frequencies within the range 30,000-100,000 kilocycles, considering the entire band as a whole, are fairly well known, there is very little quantitative material available such as is required to determine the advantages or disadvantages of various portions of this band for use by specific radio services. Since frequencies above 30,000 kilocycles have many characteristics in common which render them particularly useful for a great many services, it has been found that the majority of licensees operating in the experimental service, in reporting the results of their work, report in substance as follows:

That the frequencies used in their experimental work—no matter what portion of the frequency band used—are ideally suited for the particular service in which they have been endeavoring to determine their practical application.

Such information, although of value in establishing the probable need of frequencies of the various commercial interests and the numerous applications of the frequencies, is not very helpful in attempts to evaluate various portions of the entire frequency range for various services, the requirements and operating conditions in which are all very different. In addition, regardless of certain transmission characteristics typical of the entire band, there are physical properties and factors to be considered by reason of which certain sections or portions of the band are particularly suitable for specific purposes, and these also are known to vary widely throughout the frequency range to be considered for allocation.

Some comprehensive reports containing very useful material on the subject of ultra-high-frequency wave propagation have been received by the commission from the licensees of experimental stations. Many valuable papers on the subject have also been published by research organizations. Research work undertaken by commercial companies, however, usually has a specific objective, which naturally limits the ground covered.

Factors to Be Considered

The factors which enter into the allocation problem must be considered by the Commission over a much broader field. The problem may be conveniently divided into three parts.

I. A study of the frequency band to be allocated from the technical side alone. This requires a study of:

1. Frequency versus field-intensity characteristics for various ranges and specific areas.

2. The effect of altitude of receiving and transmitting antennas.

3. The transmission characteristics of various frequency bands throughout the total range as determined by natural transmission phenomena, such as reflection, absorption, diffraction, refraction, polarization and noise.

II. Evaluation of the services as such from the standpoint of public need and benefit. This requires consideration of such matters as:

1. The dependence of the service on radio rather than wire lines.

2. The number of stations needed to assure the service.

3. The probable number of people who will receive its benefits.

4. The social and economic importance of the service.

5. The safety of life and protection of property factors.

6. The probability of practical establishment of the service and the degree of public support which it is likely to receive.

III. The apparatus available for, and the operating conditions obtaining within each service. This involves such matters as:

1. The distances over which communication will be required for point-to-point services.

2. The areas which it will be necessary to cover for services such as broadcast, television and police.

3. The field intensities required, which will vary greatly for different types of services.

4. The relative amount of radio and industrial interference likely to be encountered.

5. The relative amount of noise which may be tolerated in the different services.

6. The receivers available and their selectivity and stability characteristics.

7. The types of antennas which are practicable.

8. The frequency tolerances which may be maintained and the channel widths which may be prescribed.

All of the above factors must be considered with respect to the total number of frequencies available for allocation.

It is in connection with parts I and III that data are lacking. Information relative to the transmission characteristics of the frequencies within the range 100,000-500,000 kilocycles is very meager compared to that available within the range 30,000-100,000 kilocycles. In addition, certain phenomena are being reported in regard to which no definite connection with theory and experiment has as yet been made. Among these may be mentioned the reception of usable signals far beyond the ranges predictable by the diffraction theory, the diurnal variation of signals, and the appearance of fading at the greater ranges, although most recent experimental studies indicate that variations in transmission below the line of sight may be due to refraction and the changing moisture content of the atmosphere.

Effects of Allocation

The Commission appreciates the desirability of allocating all or a part of the ultra-high frequencies for commercial use as soon as this can be done in such manner as to best meet the needs of all services. Such would probably release frequencies in the lower frequency bands, thereby relieving the congestion which now exists in some services, thus increasing the efficiency of these services. It would in all probability also provide many new services by reason of which the public would receive many benefits.

On the other hand, the deleterious effects of an allocation prematurely made are apparent. The allocation must be based on a firm foundation of engineering facts, in order that it may stand the test of time. There should be no necessity—if such can possibly be avoided—for revision of the plan at some later date, requiring shifts of the frequencies among the services and consequent redesign or replacement of equipment. This would retard rather than accelerate the progress of the radio-communication art. In order to avoid such contingency it has been the Commission's policy to proceed with caution and to strictly maintain the experimental status of the frequencies until such time as the requisite information becomes available. At the same time it has also been the Commission's policy to encourage all experimental licensees in their efforts to find practical applications for the frequencies, to the end that the desired information may be brought forth as soon as possible.

The Present Status

At the present time there are 991 licensed general and special experimental stations operating on the ultra-high frequencies. Of these, many are engaged in pure research work, but the greater number are particularly interested in specific services and are endeavoring to obtain recognition and eventual establishment of these services. The services in which licensees have shown the greatest interest are aviation, municipal police, state police, broadcast pickup, broadcast, visual broadcast, special emergency, geophysical, a proposed service for railroads, a proposed service for forestry, fixed public and public coastal, fixed public press, and coastal and ship harbor. There are, for example, 111 municipalities now operating 97 fixed stations and 248 portable-mobile stations on police automobiles furnishing two-way communication service on the ultra-high frequencies on an experimental basis.

Most of the experimental work is being carried on in the band 30,000-42,000 kilocycles. In order to avoid congestion and minimize interference in this band, certain groups of frequencies have been chosen for experimental work, the frequencies in each group being selected with considerable spread throughout the band in order to afford an opportunity to determine the most

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suitable frequencies for various services within this range. These groups are:

Experimental Service	*Frequencies (kc)*
General experimental station (police)	30,100, 33,100, 37,100, 40,100
General experimental station (broadcast pickup)	31,100, 34,600, 37,600, 40,600
General experimental station (miscellaneous services)	31,600, 35,600, 38,600, 41,000

The frequencies within the band 42,000-56,000 kilocycles and 60,000-86,000 kilocycles are being used for experimental visual broadcasting. Some work is being done on frequencies above 86,000 kilocycles by licensees essentially interested in fixed point-to-point telephone and telegraph communication.

The frequencies in all of the ranges mentioned above are being used also by Government departments for their experimental work, under authority granted by Executive Order of the President.

Types of Data Needed

The following outline gives the types of data which are most needed:

1. The total frequency range over which communication will be practicable, utilizing conventional vacuum-tube circuits and new tubes. By new vacuum tubes is meant those not now commercially available, but which may be obtained for experimental purposes from the commercial laboratories, and it may reasonably be presumed, will become available for commercial use in the near future.

2. The field-intensity characteristics of the entire frequency band for specific ranges and for coverage of specific areas, considering the height above ground of transmitting and receiving antennas, reasonably expected to be obtained in practice.

3. The favorable or unfavorable trend of various sections or portions of the entire frequency band as determined by or limited by:
   a. Transmitter design.
   b. Receiver design.
   c. Antennas and antenna locations.
   d. Character of terrain.
   e. Polarization.
   f. Attenuation, through that portion of the paths of the direct and indirect ray where buildings, trees, vegetation, and other absorbing materials are encountered.
   g. Reflection phenomena and interference patterns.
   h. Refraction.
   i. Diffraction.
   j. Noise.

4. The advantages or disadvantages of the various portions of the entire frequency band for radio communication as determined or limited by the amount that the favorable or unfavorable trends as found above are augmented, reduced, or nullified by others.

The Commission would greatly appreciate having information or data which might be useful in this study made available to their engineering staff. Data or reports which are confidential will be kept in that status.

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COMMISSION ORDER NO. 12-A

THE COMMISSION on July 31, 1935, adopted Commission Order No. 12-A making certain revisions in Tariff Circular No. 1. The effective date of the circular remains as originally published, September 1, 1935, but the posting requirements are made effective January 1, 1936.

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RULES 229 AND 262 MODIFIED

THE COMMISSION on August 14, 1935, modified Rule 229 to read in part as follows:

	Frequency (kilocycles)	*Service*
(page 75)	4650	Aviation
(page 75)	4690	Aviation
(page 76)	5310	Aviation
(page 77)	5885} 5890} 5887.5	Aviation
(page 78)	e8130	Government and Aviation

The Commission on August 20, 1935, modified Rule 262a, B, b, to read in part as follows:

Northern Transcontinental Chain and Feeders (Red)

Available for aeronautical point-to-point stations.

5310 kc

Northwestern Continental Chain and Feeders (Purple)

Available for aeronautical and aircraft stations.

2854 kc 3005 kc 5377.5 kc—day only.
2994 kc 5887.5 kc—subject to the condition that no interference is caused to the international service.

Available for aeronautical point-to-point stations.

2644 kc 8130 kc—day only, subject to the condition that no interference is caused to Government stations.
6490 kc—day only.

Mid-Continental Chain and Feeders (Yellow)

Available for aeronautical point-to-point stations.

2912 kc 5887.5 kc—subject to the condition that no interference is caused to the international service.
3485 kc
5042.5 kc
5682.5 kc

Available for aeronautical and aircraft stations.

2640 kc 4650 kc 4690 kc

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COMMISSION ORDER NO. 13

AT A GENERAL SESSION of the Federal Communications Commission held at its office in Washington, D. C., on August 14 the Commission having under consideration the subject of annual reports from carriers subject to the Communications Act of 1934 and from persons as defined in Section 3 (i) of that Act, directly or indirectly controlling or controlled by, or under direct or indirect common control with, any such carrier:

It was ordered, that each and every carrier subject to the Communications Act of 1934 and each and every person directly or indirectly controlling or controlled by, or under direct or indirect common control with, any such carrier shall make and file, in duplicate, with the Commission, on or before the thirty-first day of March in each year, an annual report as provided in Section 219 of the Communications Act of 1934, covering the period of twelve months ending on the thirty-first day of December next prior to said date; provided, however, that annual reports for the period of twelve months ending on December 21, 1934, shall be made and filed with this Commission by every such carrier and person on or before October 15, 1935.

It was further ordered, that the annual reports shall severally be in accordance with the blank forms of report adopted and furnished by the Commission for the required returns and with the instructions in such forms, and shall contain full and specific answers to all questions propounded in the forms and all the information called for therein, whether by questions, or forms of tabular statements, or otherwise.

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APPLICATIONS GRANTED FOR NEW STATIONS

Telegraph Division

August 7, 1935.

AERONAUTICAL RADIO, Inc., Tulsa, Oklahoma, granted construction permit, aviation aeronautical, 2912, 5042.5 kc, 30 watts.

METROPOLITAN POLICE DEPARTMENT, District of Columbia, granted construction permit (two applications), portable-mobile, general experimental, municipal police in emergency service, 30,100, 33,100, 37,100, 40,100 kc, 5 watts.

THE FRANKLIN INSTITUTE of the State of Pennsylvania, Swarthmore, granted license, free balloon, general experimental, to be used in conducting a program of experimental research in connection with the measurement of cosmic-ray intensities, 12,862.5, 17,310, 23,100, 25,700, 26,000, 31,600, 41,000, 86,000 kc, 10 watts.

WASHINGTON INSTITUTE OF TECHNOLOGY, College Park, Maryland, granted construction permit, portable, special experimental, 278 kc, 400 watts.

Broadcast Division

August 13, 1935.

HAROLD F. GROSS, M. BLISS KEELER, L. A. VERSLUIS, doing business as The Capitol City Broadcasting Co., Lansing, Michigan, granted construction permit, portable-mobile, general experimental, 31,100, 34,600, 37,600, 40,600 kc, 15 watts.

THE PULITZER PUBLISHING CO., St. Louis, Missouri, granted construction permit, 31,600, 35,600, 38,600, 41,000, 86,000-400,000 kc, 100 watts.

GENERAL ELECTRIC CO., Schenectady, New York, granted construction permit, portable-mobile, broadcast pickup station in temporary service, 1606, 2020, 2102, 2760 kc, 50 watts.

PALESTINE BROADCASTING ASSOCIATION, John C. Welch, Wm. M. Keller, Bonner Frezzell, Palestine, Texas, granted construction permit, 1420 kc, 100 watts, daytime.

GEORGE B. BAIREY, Valley City, North Dakota, granted construction permit, 1500 kc, 100 watts, unlimited time.

August 20, 1935.

NORTHWESTERN BROADCASTING, Inc., Minneapolis, Minnesota, granted construction permit, general experimental, 31,600, 35,600, 38,600, 41,000, 86,000-400,000, 401,000 kc and above, 50 watts.

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VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGonigle, Secretary, 112 Willoughby Avenue, Brooklyn, N. Y.

AUSTIN Y. TUEL
Late Vice-President and General Manager, Mackay Radio and Telegraph Co.

AUSTIN Y. TUEL

Austin Y. Tuel, Vice-President and General Manager of the Mackay Radio and Telegraph Company, died suddenly on the morning of Tuesday, August 27, 1935, at the Murray Hill Hospital in New York City. Mr. Tuel was fifty-three years old, having been born on August 21, 1882, at Mt. Carmel, Illinois.

Mr. Tuel, after being graduated from high school at Mt. Carmel in 1900, started as a telegraph operator on the CCC & St. Paul Railroad, and continued as a railroad operator for various roads in the South and West until 1909, when he entered the service of the United Wireless Company at Seattle, Washington. He was soon appointed by Mr. C. B. Cooper as manager of that company's station at Salem, Oregon, and within a year was transferred to San Francisco to assume charge of the newly opened station of the company in that city.

In 1910, Mr. Tuel joined the Federal Telegraph Company on the West Coast and remained in their employ until April 12, 1917, when he enrolled in the United States Navy, as Lieutenant, Junior Grade, and subsequently was made Naval Communications Officer at San Francisco, in which capacity he served until mustered out of service as a Senior Lieutenant on December 1, 1919.

He then returned to the Federal Telegraph Company and was transferred to Washington, D. C., as Resident Engineer, continuing at this post until early in 1921, when he was appointed General Manager for the company with headquarters at San Francisco.

Mr. Tuel held this position until 1927. When the Mackay Radio and Telegraph Company was formed, he was appointed Vice-President and General Manager of that company, a position he occupied until his death.

Mr. Tuel was long a Veteran member of the Veteran Wireless Operators Association, becoming a Life Member in 1932. He was always a staunch supporter of Association activities and invariably attended our Annual Cruises. Beloved by his fellow members in our organization, amiable and courteous to all with whom he came in contact, admired and respected by the employees working under him in his official capacities with various communications companies, considered an outstanding executive by his contemporaries in the communications industry, his passing leaves a gap difficult to fill. We mourn his loss.

On behalf of the membership of our Association we tender our deepest sympathies and condolences to his bereaved widow.

RADIO DURING WORLD WAR

The German Pacific Squadron, consisting of the *Gneisnau*, *Scharnhorst* and other cruisers, was abroad in the Pacific, and as their position was unknown to the Military Authorities here, great anxiety was experienced.

The New Zealand Government was about to dispatch overseas the Main Body of the New Zealand Expeditionary Force, and some of the transports had already left Wellington when a message was intercepted from the *Scharnhorst* to the *Gneisnau*. The message was in code but was soon deciphered and proved that Von Spee, Admiral commanding the German Squadron, was aware of the departure of the transports. The transports were immediately recalled and their departure delayed for three weeks. The German Squadron in the meantime moved towards the coast of South America, where it met and destroyed a British Squadron under Admiral Craddock, only to meet its fate at the Battle of Falkland when a British Squadron under Admiral Sturdee destroyed the whole of the German Squadron.

The radio operator who intercepted the message which saved the lives of many of the members of the New Zealand Expeditionary Force is Clive Drummond, in charge of the Mt. Etako Short-Wave Station, Wellington, New Zealand, at the outbreak of the war in 1914, and at present Chief Announcer for the New Zealand Broadcasting Board at their key station, 2YA, at Wellington. Mr. Drummond inquires regarding requirements for Veteran membership in our Association.

FALL ACTIVITY

Let's go. The summer is over—the fall is with us. We must begin to plan for the big event of the winter season—the Annual Cruise. Many details must be arranged and an early start will assure unprecedented success for this event. The first meeting of the fall season will be held at the Hotel Montclair, on Thursday evening, October 3, 1935, at 6 P. M. We urge each and every member to make every effort to be with us on that evening to contribute suggestions and ideas on future activities of the Association. We will expect you at the Montclair on the third of October.

PERSONALS

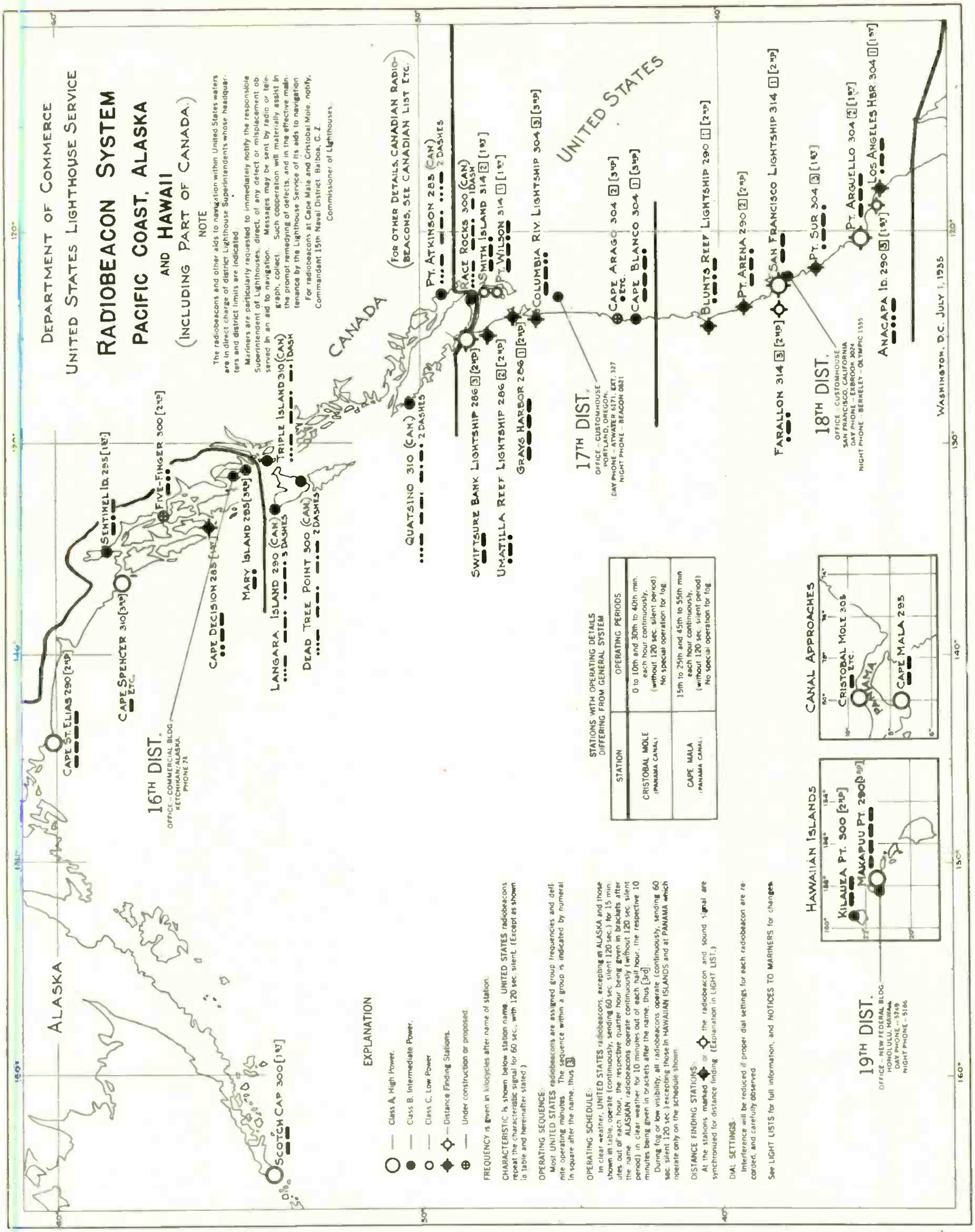
Viggo H. C. Eberlin, formerly Association Treasurer, at present stationed at Miami, Florida, with the Tropical Company as Technician, recently returned to New York on a vacation and to the surprise of his many friends, accompanied by a blushing bride. We are sorry VHC had so little time to spend with us and we bid him fond adieu on his return honeymoon and continued success in his future endeavors. . . . Anthony Cirenza, at the suggestion of Ben Beckerman, applies for Associate Membership in our Association. . . . Glad to hear from Herman Zimmerman. . . . Carl O. Peterson, just returned from the Byrd Expedition, sends notice of change of address. He now resides at 66 South Bay Avenue, Freeport, N. Y. . . . Be sure to let us know when you move. Just a post card will do and it will materially reduce the work of the Secretary. . . . An inquiry from L. W. Briggs of station WIBX in Utica re membership. . . . C. D. Guthrie tells us that he has received many letters from former associates in the U. S. Navy back in the early 1900's because of his anecdotes appearing on this page the past few issues. Captain R. B. Woolverton, U. S. Army Signal Corps, stationed at Denver, Colo., wrote to "Jerry" saying he remembered vividly many of the incidents enumerated by him concerning Navy radio 'way back when! Captain Woolverton was then in the Navy doing radio work. We hope to receive some material from RBW and from the many others familiar with the development of radio from the "dark days." . . . A. F. Wallis, Mackay Marine Superintendent, has been making frequent out-of-town trips equipping numerous ships with the latest equipment. . . . A little reminder from Sergeant Pearce —lest we forget—that he is still in the printing business in Long Island City. . . . Although we went north past Bear Mountain numerous times this summer, we failed to stop off to see Geo. P. Smith, a veteran radioman from early Navy days, who has charge of the concessions at Bear Mountain Park.

FETZ JOINS DRIVER

Wilbur B. Driver Company, Newark, New Jersey, manufacturers of Tophet, Cupron and other resistance alloys announces that Mr. Erich Fetz has joined its metallurgical staff as research metallurgist. Mr. Fetz has had extended metallurgical experience in this country and abroad.

McCOY JOINS OLESEN STUDIOS

Hollywood Recording Studios, Hollywood, went out of business early in September and its former owner, Dickson McCoy, joined the technical staff of the Otto K. Olesen Sound Studios in the same city.



MAP No. 10 -- Radiobeacon System, Pacific Coast, Alaska and Hawaii [Including part of Canada]

SHOWING THE RADIOBEACON STATIONS, WITH CODE SIGNALS AND OPERATING SCHEDULES, AS PREPARED BY THE UNITED STATES LIGHTHOUSE SERVICE, U.S. DEPARTMENT OF COMMERCE. CORRECTED TO JULY 1, 1935 (REVISION OF MAP NO. 8)

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OVER THE TAPE . . .

NEWS OF THE RADIO, TELEGRAPH AND TELEPHONE INDUSTRIES

LEAR DIRECTION FINDER PAMPHLET

Lear Developments, Inc., 125 West 17th St., New York, N. Y., has released for distribution a brochure dealing with the "Lear-O-Scope" Aircraft Radio Direction Finder. General details of the equipment are presented.

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AUGUSTA TO INSTALL POLICE RADIO SYSTEM

Augusta, Ga., will inaugurate a medium-high-frequency, one-way police radio system early in September. The system being installed by General Electric engineers will provide police radio service to Richmond County, and both city and county police dispatches will be broadcast from Augusta.

Ten of the city's patrol cars will be equipped with receivers. At headquarters a 250-watt transmitter and a receiver will be installed. A 120-foot radio antenna will be erected on a steel structure rising through and above the roof of the barracks garage.

A medium-high rather than an ultra-high frequency transmitter was chosen in this case because Georgia officials desire to provide radio protection for Richmond County, as well as for Augusta, and because the communication range of ultra-high-frequency transmitters at the present time is limited practically to "line of sight" areas, and ordinarily would not cover a county.

It will be possible for Augusta to have two-way communication later by installing ultra-high-frequency transmitters in the patrol cars, and an ultra-high-frequency talk-back receiver at police headquarters.

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NEW GENERAL CABLE BROCHURE

General Cable Corp., 420 Lexington Ave., New York, N. Y., has released for distribution a brochure titled "Advance in Cable Design."

The brochure deals with the new paper insulated power cables developed by General Cable.

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RADIO TRANSCRIPTION CO.

The Radio Transcription Company of America has elected C. C. Pyle president and general manager and the home office has moved to 1509 N. Vine St., Los Angeles, Cal., where the firm was established five years ago. Branches will continue to be operated in New York and Chicago.

Frank Zambreno, in charge of the Chicago branch, returned Sept. 1 after four months in San Diego managing the Ripley exhibit at the exposition. Miss Esther Donnan, in temporary charge of that office, will remain in an executive capacity. George H. Field is no longer New York representative for Transco, but a district manager will be appointed there in October.

The firm, which produces and distributes electrical transcription programs to radio stations, called a sales convention in Hollywood early in September with its field managers present for conference.

The fall production schedule calls for eight new programs a week over a period of 39 weeks.

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HERTZBERG JOINS WHOLESALE

Robert Hertzberg, who has been identified with publicity and sales promotion activities in the radio field since the inception of broadcasting, has been appointed advertising manager of Wholesale Radio Service Co., Inc., 100 Sixth Avenue, New York, N. Y.

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FREEMAN LANG INSTALLS NEW EQUIPMENT

RCA speech-input equipment has been installed in the Hollywood sound studios of Freeman Lang. It will be connected to a small, low-powered radio transmitter with a dummy antenna.

All Freeman Lang transcription productions will be tested on the apparatus, and actually broadcast within the confines of a shielded room.

The signals will then be picked up on a standard high-fidelity radio receiver to thus fully assure a program that is correct in every detail for later reproduction from a regular broadcast studio, it is stated.

The Lang studios, the past ten years in the business of producing transcriptions for program building organizations, in September will start to produce transcribed programs of their own.

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FERRANTI ELECTROSTATIC VOLTMETER

A new illustrated folder which gives complete technical data, prices, etc., covering the new Ferranti Electrostatic Voltmeter, is announced. This booklet is available without charge upon request to Ferranti Electric, Incorporated, 130 West 42nd Street, New York, N. Y.

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HAMMARLUND CORRECTION

In the write-up on the Hammarlund Acorn Tube Socket, appearing on page 30 of the August issue, it is stated that the five double-grip prongs are tinned phosphor bronze. This is incorrect; the prongs are silver plated.

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RCA VICTOR DE LUXE TRANSCRIPTION TURNTABLE

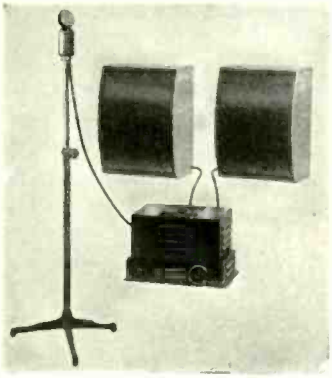
The new RCA Victor De Luxe Transcription Turntable, Type 70-A, is fully described in Bulletin No. 53, released by the Transmitter Section of RCA Manufacturing Co., Inc., Camden, N. J.

The Transmitter Section has also released Bulletin 33-A which deals with the RCA Type 46-A Four-Position Mixer Panel.

NEW REMLER PORTABLE REMOTE AMPLIFIER

The Remler AP3-18 is a complete new modern high-gain remote, consisting of high-fidelity, high-gain amplifier with a-c power supply, housed in two compact units, mounted on duralumin panels and encased in sturdily built, reinforced, fibre-covered cases fitted with heavy chromium plated hardware.

The amplifier is said to incorporate exclusive engineering refinements ordinarily associated with studio equipment, and includes convenient line test feature. The



latter is controlled by a panel switch which introduces a small a-c signal of power-line frequency into the amplifier input. This appears in the output of the amplifier and is indicated by the V. I. meter. The reading is controlled by the master gain attenuator. This signal not only checks the operation of the amplifier but may be used to test the telephone loop.

The amplifier is a four-stage, resistance-coupled push-pull unit with an overall gain, including mixer loss, of 93 db. It has been designed for use with three dynamic, velocity or inductor microphones without pre-amplification. Channels one and two may be provided with power supply for condenser microphone.

The circuit design comprises a high permeability input transformer, doubly shielded and cushioned against microphonic vibration, two type 77 tubes, triode connected, as voltage amplifiers; a type 79 dual triode tube used as third stage voltage amplifier and phase-inverter to supply equal voltages of opposite phase to the grids of the push-pull output stage, and a type 6A6 dual triode tube in a Class A output circuit. The amplifier may be used with batteries where a-c is not available.

Each of the three input channels is controlled by a Remler tapped-type, constant-impedance attenuator. This control provides attenuation in steps of approximately 5/6 db to 45 db attenuation; then fades to infinite attenuation in three additional increasing steps.

The standard input impedance of each channel is 50 ohms. An input impedance of 200 ohms, each channel, may be provided if specified.

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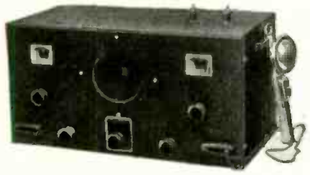

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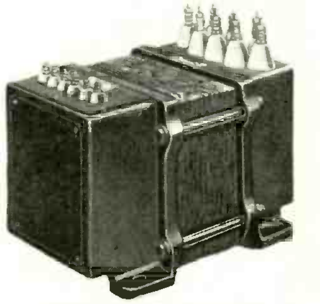
TRANSFORMERS
for Transmitting



Above — AmerTran air-cooled transmitting plate transformer —sizes up to 7 kva.

Below—AmerTran air-cooled transmitting filament transformer.

AmerTran's line of air-cooled transmitting transformers are designed to meet the most rigid broadcast station requirements. Units are of the highest quality and standard types are available to meet all usual requirements in rectifiers utilizing either type '66 or '72 tubes. The illustrations show our new improved mountings and standard ratings are listed in Bulletin No. 1002 . . . *May we send you a copy?*

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BROADCASTERS both large and small admit that *dependability* is their first consideration in the purchase of condensers. Price plays little part in their specifications. The cost of time lost, due to defective, inefficient condensers far overbalances the small difference that lies between guaranteed, long proven condensers and nondescript merchandise. That is why CORNELL-DUBILIER condensers are specified in all broadcast installations.

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THE MARKET PLACE

NEW PRODUCTS FOR THE COMMUNICATION AND BROADCAST FIELDS

GENERAL RADIO TYPE 713-A BEAT-FREQUENCY OSCILLATOR

The General Radio Company, 30 State St., Cambridge A, Mass., has announced a newly designed a-c operated beat-frequency oscillator, having as its outstanding features high power output, excellent waveform, constant output, and wide frequency range. This oscillator, listed as type 713-A, replaces the Type 513 unit.

The Type 713-A Beat-Frequency Oscillator is shown in the accompanying illustration. A high degree of frequency stability has been introduced through the use of a pentode oscillator circuit. To reduce temperature variation, the two tuned circuits have been symmetrically placed and mounted on a heavy aluminum slab which is thermally insulated from all heated portions of the circuit, including the oscillator tubes themselves, reducing the temperature variations due to heating within the oscillator to a somewhat lower order than normal room temperature fluctuations.

Good waveform is obtained by the use of a balanced push-pull detector circuit which eliminates the second harmonic. The amplifier, filter and transformer design is such as to provide substantially uniform gain from 10 to 20,000 cycles. It was found impossible to pass the full 10-cycle output of 2 watts—the undistorted output of the oscillator—through any transformer of practical size without serious distortion. Therefore a switch has been provided so that the input to the detector can be reduced and with it the level throughout the instrument. At the reduced output level, the distortion remains at less than 1% down to 10 cycles.

An "incremental pitch" condenser, with direct-reading scale of ± 50 cycles, has been included in the Type 713-A Oscillator. This dial permits resonance curves to be taken as well as permitting the auditory tests. The use of this dial has been enhanced by engraving a line at least every 100 cycles on the main scale, thereby effectively providing a calibration point for every cycle throughout the scale.

SOUND-ON-FILM

Sound-on-film for radio stations has become an actuality with the Freeman Lang sound studios in Hollywood, ready to place such service on a commercial basis.

While the studio will produce some film for radio distribution, it is also negotiating with several major film studios for a library of musical numbers.

The machine itself has been developed to the point where it can use eight sound tracks. It was originally demonstrated at the July NAB meetings in Colorado Springs. The machine which was used for demonstration has been sold to the new radio station in Hilo, T. H., and will be used there when the station is dedicated late in September.

NEW KELLOGG HANDSET FOR 5-METER WORK

The Kellogg Switchboard and Supply Co., Chicago, has produced a handset with the receiver and transmitter mounted on a handle as a single convenient unit. Only one hand is required to use it and the handset is always in correct position for either talking or listening. This design also positions the transmitter so that it is always at the correct distance from the mouth for easy, natural talking. The unit is compact, sturdily constructed, and attractive in appearance.

The handset has a 70-ohm and 2000-ohm receiver. The 70-ohm receiver is provided so that an output transformer may be used on the receiving set output, with the secondary winding of low impedance to match the headsets. The impedance of this receiver at 1000 cycles is 235 ohms. The high resistance receiver is provided so that it may be connected in the plate circuit of the output tube without the use of a transformer, and has impedance of 8,460 at 1000 cycles.

The microphone is of the stretched diaphragm type, having a single button. This diaphragm is of phosphor bronze, gold plated, and will stand up under normal climatic conditions. Special microphone carbon is used, and the diaphragm assembly is protected with a fine mesh screen so as to prevent injury in handling. The frequency response of the microphone has a slightly rising characteristic to 3000 cycles. The normal receiver response when clamped tightly to the ear is low on the high end, and the design of the microphone is such as to compensate for some of this loss. The increase of the high-frequency end is not sufficient to cause any undue emphasis when amplified for loudspeaker use so that when used either into a head receiver or into a loudspeaker, voice quality is exceptionally good. The resistance is 100 ohms, and should be matched to the input of the transceiver. The operating current is 25 ma and is usually supplied by a 3-volt battery.

The microphone and receiver are both of light weight, and are mounted on a light-weight aluminum handle finished in black baked enamel. It is provided with a moistureproof, six-foot, four-conductor cord. The entire handset weighs only 14⅝ ounces.

NEW COMMUNICATIONS-TYPE CRYSTAL MICROPHONE

A new diaphragm-type crystal microphone, specially designed for communications service in airways, police, commercial and amateur radiophone systems, has recently been announced by Shure Brothers Company, 215 West Huron Street, Chicago. The new model is known as the 70S, and is furnished with a convenient desk mount and two-conductor shielded cable.

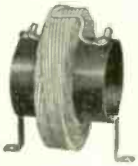
The 70S is said to have been designed to produce a higher effective percentage modulation on "intelligibility" speech frequencies than can be obtained with the ordinary speech-input system. The response increases linearly a total of 20 db in progressing from 60 to 2,000 cycles, is substantially uniform from 2,000 to above 4,000 cycles, followed by gradual cut-off, it is said. The response curve is free from sharp peaks which tend to produce "harsh" reproduction.

The Model 70S is connected to the transmitter in the usual manner, no circuit changes being required.

MILLER LINE-FILTER CHOKE

Elimination of high-frequency disturbances from power-supply lines is accomplished by a new line-filter choke developed by the J. W. Miller Company, 5917 S. Main Street, Los Angeles, for use with receivers, transmitters or any source of interference.

Duo-lateral wound for minimum distributed capacity, the newly designed choke is available in various wire sizes of 2-, 5-, 10- and 20-ampere carrying capacity.



Use of a duo-lateral wound choke is said to make a radio receiver more selective by by-passing the station signals picked up through the electric wiring. Used with a transmitter, the Miller line filter keeps the signal in the antenna and out of the a-c line, it is said.

In general, the filter choke may be used for radio receivers, transmitters, vibrating and rotating machinery, mercury arc, mercury rectifiers and wherever it is desired to eliminate interference from either a-c or d-c supply lines.

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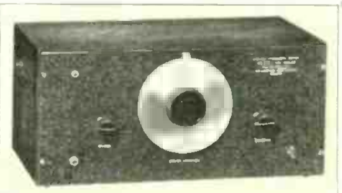

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