Communication and Broadcast Engineering

VOL. 2 NO. 7

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The Journal of World Communication

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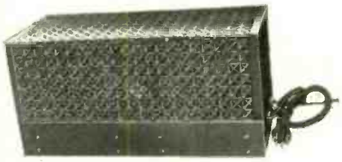

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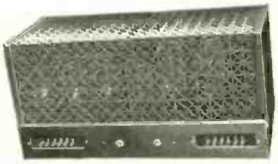

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EDITORIAL

CRIME AND TRAFFIC CONTROL

THE RAPID INCREASE in crime, and the complexity of modern automotive traffic conditions, have led to efforts on the part of the Federal Government, individual states and cities, and such organizations as the National Safety Council, to ease the burden these factors place upon society.

Both crime and automotive traffic conditions are directly or indirectly by-products of science. Though science is the root in each instance, it does not hold that scientific methods should be utilized as counteractives; yet, the fact remains that the only effective measures so far introduced have had at least an atmosphere of science about them, with radio playing the major role.

Each advance in the development of radio communication equipment, and in the practical and effective utilization of new ether channels, has resulted in placing at the disposal of law-enforcement groups and organizations instituted as social stabilizers new methods for combating conditions at variance with social order. Witness the effectiveness in the control of crime gained through the use of police-radio communication systems, and the evident improvements in intercommunication being realized by means of two-way, ultra-short-wave systems. Yet the surface has hardly been scratched.

With the exception of law-enforcement units tied in on the teletype networks, crime control has been localized. The success of many criminals in escaping the arms of the law by slipping from one city or state into another, or taking advantage of open country not under patrol or outside the communication network, has motivated the law-enforcement agencies in the direction of inter-city and inter-state communication tie-ins for the speedy facilities they offer. Moreover, there is talk of a national radio network, under the supervision of the Federal Government, to function as a supplementary unit to present police-radio systems. In this manner the Federal "G-Men" hope to tighten the net on crime.

Mr. F. C. McMullen, of the Western Electric Company, who is concerned principally with aircraft radio, advocates as a further extension to the arm of the law, the use of two-way, ultra-short-wave radiophone equipment in planes and cars. The suggestion is striking in that the speed of a plane and the wide visual range of the pilot permits, first, the effective patrol of wide areas, such as gained by forest air patrols and, second, a perfect view of all traffic arteries. Thus, in the event of a crime involving escape by auto, such details as available are transmitted immediately to the plane pilot who, upon picking up the trail of the criminals, may readily direct the pursuit of the police cruiser cars . . . and, if necessary, communicate immediately with the headquarters station with requests for a flash to bordering towns or cities over the teletype—or by radio, if such inter-communication exists.

Mr. McMullen advocates the same set-up for the control of traffic where congestion occurs. The use of an Autogyro, which has the advantage of being able to hover above the ground, would provide an ideal form of air traffic-cop. Such a plane could take care of the primary supervision of traffic movements over very wide areas and, on spotting jams on main or supplementary arteries, fly to the point, and hover in this vicinity. Then, after a survey of conditions in other traffic lanes, provide re-routing instructions to police cruiser cars—thus returning traffic flow to normal with the least possible delay.

Needless to say, the use of a single Autogyro, with provisions for two-way radio communication with police emergency units and headquarters stations, might well have resulted in the saving of many lives during the recent floods in the East Atlantic region. For that matter, the uses to which such a system could be put, are too numerable to mention.

COMMUNICATION & BROADCAST ENGINEERING

FOR JULY, 1935

CLASS B AND C AMPLIFIER COMPUTATIONS*

By DR. VICTOR A. BABITS, A.M.I.E.E., A.M.I.R.E.
ASST. PROFESSOR, UNIVERSITY OF TECHNICAL SCIENCES, BUDAPEST

● **GRAPHICAL METHODS FOR COMPUTING VALUES OF HIGH-FREQUENCY CLASS B AND C AMPLIFIERS**

W. L. EVERITT and C. J. de Lusannet de la Sablonier[1] recently published practical papers regarding high-frequency Class B and C amplifiers. The most interesting point of Everitt's computations was the final result, showing that the original value of plate resistance of the tubes was apparently increased to β times its original value, where

$$\beta = \frac{\pi}{\theta_1 - \sin\theta_1 \cos\theta_1} \quad \ldots\ldots\ldots\ldots (1)$$

From this it is apparent that the increase of the plate resistance is a function of the operating angle θ_1; and $2\,\theta_1$ is the angle while plate current is flowing. The amplitude of the fundamental alternating-current component of the plate current is necessary for the computation of voltages and power output, which, following Everitt, is

$$I_1 = \frac{\mu E_g}{R_L + \beta R_P}$$

Only the increase of the plate resistance is apparent and it is derived from the interpretation of the results of the computation.

ANOTHER METHOD

The computation can also be made in another way. By this method, however, our final result is that the

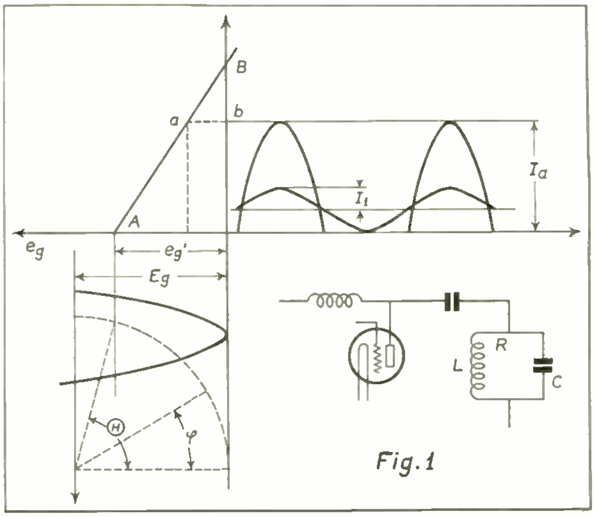


Fig. 1

*Paper received April 22, 1935.

[1]W. L. Everitt: "Optimum Operating Conditions for Class C Amplifiers," *Proc. I.R.E.*, Vol. 22, pp. 152-176, February, 1934.

C. J. de Lusannet de la Sablonier: "The Design of Class B Amplifiers," *The Wireless Engineer*, Vol. 12, pp. 133-140, March, 1935.

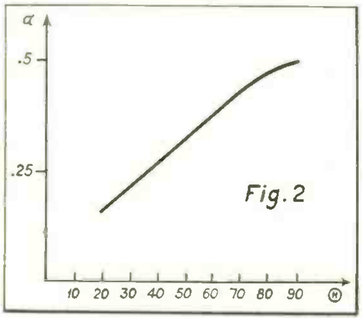
grid voltage apparently decreases and the impedance of the load circuit increases to α times its value as a function of the operating angle. Where

$$\alpha = \frac{I_1}{I_a} < 1$$

$$I_a = M_d E_g (1 - \cos\theta) \qquad (2)$$

I_a being the maximum value of the plate current
E_g being the maximum value of varying component of grid voltage
M_d being dynamic mutual conductance
θ being the operating angle.

Everitt has shown that no error is made by considering the dynamic characteristic of the tubes as linear.



Hence we may assume that the amplifier is a linear unit.

Referring to Fig. 1, let $R_L = \frac{L}{CR}$, the impedance of the tank circuit, if $LC\omega^2 = 1$. Then the maximum decrease of the plate voltage is

$$e_{ab} = I_1 R_L \cdot \frac{1}{\mu}$$

Practically, only the fundamental alternating-current component of the plate current creates a voltage drop along the load impedance, because the voltage drop made by the upper harmonics is negligible.

If the operating angle is θ, the following equations result from equation (2).

$$\frac{I_1 R_L}{\mu} + \frac{I_a R_P}{\mu} = E_g (1 - \cos\theta)$$

$$\frac{I_a}{\mu} (\alpha R_L + R_P) = E_g (1 - \cos\theta)$$

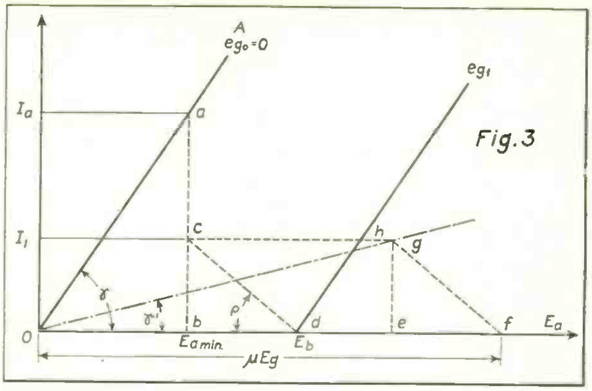
$$I_a = \frac{\mu E_g (1 - \cos\theta)}{R_P + \alpha R_L}$$

$$I_1 = \frac{\mu E_g (1 - \cos\theta)\alpha}{R_P + \alpha R_L} \qquad (3)$$

With a Class B amplifier, where $\theta = 90°$,

$$I_a = \frac{\mu E_g}{R_p + \alpha R_L}$$

$$I_1 = \frac{\mu E_g'}{R_P + \alpha R_L} \qquad (4)$$



Where

$$E_g' = \alpha E_g$$

Let us stipulate that $\alpha = f(\theta)$. The instantaneous value of the varying component of the plate current is

$$i_p = M_d E_g (\cos\phi - \cos\theta)$$

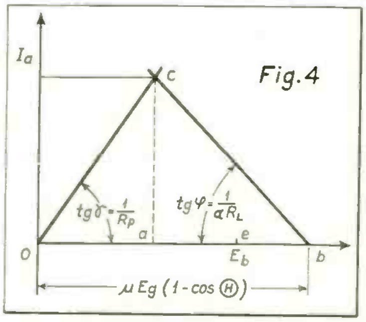
The amplitude of the fundamental alternating-current component of the plate current is, according to Fourier,

$$I_1 = \frac{2 M_d E_g}{\pi} \int_0^{\phi=\theta} (\cos\phi - \cos\theta)\cos\phi \, d\phi$$

$$I_1 = \frac{M_d E_g}{\pi} (\theta - \cos\theta \sin\theta)$$

Now, if $\alpha = \frac{I_1}{I_a}$, we may insert I_a, derived from equation (2), into this equation. This results in

$$\alpha = \frac{\theta - \cos\theta \sin\theta}{\pi (1 - \cos\theta)} \qquad (5)$$



Values of α and θ computed from equation (5) are given in Table I. These values have been plotted as shown in Fig. 2.

TABLE I

θ	α	θ	α
0	0	50	0.338
10	0.083	60	0.390*
20	0.148	70	0.434
30	0.214	80	0.474
40	0.266	90	0.5*

*Barkhausen computed these two values to be 0.391 and 0.5—*Elektronenrohren*, 1933, 2 Band p. 142.

GRAPHICAL INTERPRETATION

Let us now make a graphical interpretation of these computations. It will be found that the computations can also be made by graphical methods. We shall also learn that the graphical interpretation of the second method is the simplest.

The graphical interpretation of Everitt's computations can be seen in Fig. 3. This is the plate voltage-plate current characteristic. The line *oa* is the static characteristic of the grid voltage $e_{go} = 0$. Let E_b be the battery voltage, i.e., the maximum value of the plate voltage (quiescent value of the plate voltage); let e_{g1} be the grid voltage corresponding to the cut-off of this plate-voltage characteristic, which is the line *dh*; and let E_g be the maximum value of the varying component of grid voltage, so that $\mu E_g = of$ and the operating angle θ is less than 90°. The maximum value of the plate current is I_a, while E_a (min) is the minimum value of the plate voltage. Hence, if $I_1 = bc$, which is yet unknown, then

$$E_b - E_{a\,min} = I_1 R_L$$

$$tg\,\varrho = \frac{I}{R_L}$$

$$tg\,\gamma = \frac{1}{R_P}$$

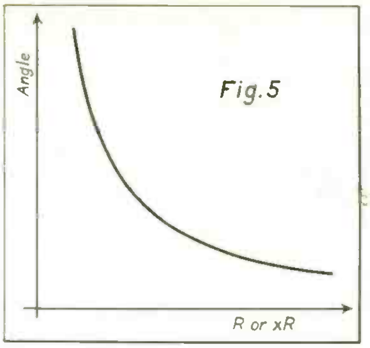
After Everitt

$$I_1 R_L + I_1 \beta R_P = \mu E_g$$

If, therefore, we draw the line *fg* at an angle ϱ from the point *f* and the line *og* from *o* at an angle γ′ (where $tg\gamma' = \frac{1}{\beta R_p}$), the crossing point will enable us to find *eg* which is the amplitude of the fundamental alternating-current component of the plate current.

Knowing E_b, E_g, θ, and β, I_1 and I_a can be found in four steps, thus:

1. μE_g locates point *f*.



2. Draw line with an angle ϱ from point *f*.
3. Draw line with an angle γ′ from the point *o*. This line will cross *fg* and determine I_1.
4. Subtract *cf* from *od*. This gives the point *b*, the vertical line *ab* being I_a.

With a Class B amplifier $\mu E_g \cong E_b$ so we can obtain I_1 in two steps.

GRAPHICAL ANALYSIS OF SECOND METHOD

New let us graphically interpret the second computation. If we know E_b, E_g, θ and α, the questionable values can be established in two steps (see Fig. 4):

1. $\mu E_g (1 - \cos\theta)$ locates point *b*.
2. Draw *bc* from *b* at an angle $tg\,\phi = \frac{1}{\alpha R_L}$ locating point *c*. The line *ac* is equal to I_a, and

$$I_1 = \alpha I_a$$

With a Class B amplifier $\mu E_g \cong E_b = oe$

and $I_1 = \frac{I_a}{2}$

The simplest way to draw the lines with the angles of γ, γ′, ϱ, and ø is to follow Fig. 5 in which the angles are plotted as a function of R and xR.

CHINESE GOVERNMENT BROADCASTING

THE CHINESE GOVERNMENT Ministry of Communications has recently purchased old XCBL, formerly operated by the China Broadcasting Company, a foreign concern. This station, now XQHC, is operating on 1,300 kilocycles, 231 meters, 250 watts, but is being remodeled to 500 watts, with crystal control. It will be a training center for Chinese radio technicians, and announcers. Within the next 12 months an increase to 1,000 watts is anticipated, German Telefunken equipment having been ordered. The station is now under the control of the Director of the Bureau of International Telegraphs of the Ministry of Communications. When alterations have been completed it will probably re-broadcast international programs, and will later serve as a feeder to the 75,000-watt station of the National Government at Nanking. Commercial broadcasting is being accepted and as the station is located in Shanghai where its programs can be controlled by whatever advertising agency places the account, such broadcasting will probably be both efficient and productive. (*Electrical Division, Department of Commerce.*)

•

RADIO RESEARCH BOARD REPORTS

THE RADIO RESEARCH BOARD, Council for Scientific and Industrial Research, Commonwealth of Australia, has issued three reports, Nos. 6, 7 and 8—otherwise known as Bulletins Nos. 87, 88 and 89, respectively.

Report No. 6 includes the following four papers: "On the Rotation of the Plane of Polarization of Long Radio Waves" by A. L. Green and Goeffrey Builder; "A Field-Intensity Set" by A. L. Green and H. B. Wood; "Measurements of Attenuation, Fading, and Interference in South-Eastern Australia, at 200 Kilocycles Per Second" by G. H. Munro and A. L. Green; and "A Frequency Recorder" by D. F. Martyn and H. B. Wood.

Report No. 7 presents the following papers: "The Propagation of Medium Radio Waves in the Ionosphere" by D. F. Martyn; "The Characteristics of Downcoming Radio Waves" by D. F. Martyn and A. L. Green; "The Influence of Electric Waves on the Ionosphere" by V. A. Bailey and D. F. Martyn; and "Long Distance Observations of Radio Waves of Medium Frequencies" by D. F. Martyn, R. O. Cherry and A. L. Green.

The following papers are included in Report No. 8: "Simultaneous Observations of Atmospherics with Cathode-Ray Direction Finders at Toowoomba and Canberra" by G. H. Munro, H. C. Webster, and A. J. Higgs; and "Atmospheric Interference with Reception" by W. J. Wark.

Copies may be obtained from H. J. Green, Government Printer, Melbourne, Australia.

Photo courtesy of Mr. Glenn E. West, E. E. Dept., Purdue University.

FIG. 3-A. REAR VIEW OF THE NEW DESIGN PROGRAM AMPLIFIER FOR BROADCAST STATIONS.

DURING THE GROWTH of the broadcasting industry from its infancy, several years ago, to its present influential status in American home life, and as an entertaining and advertising medium, the evolution of design in equipment has progressed very rapidly. As this article is meant to deal mainly with a new design speech-input amplifier, for program work, we shall briefly review the older types in the process of amplifier evolution.

EARLY PROGRAM AMPLIFIERS

All mechanical and electrical devices in radio and the allied industries have been developed in a comparatively short period of years, and so have been developed quite rapidly in comparison with machinery of other industries. Until lately, however, the design of suitable program amplifiers has been at a standstill. There have been, however, new designs placed on the market at various times during the past three or four years, but the cost combined with very few advantages made it impractical to replace the amplifiers in use. Now, with the proof that the new type tubes are much better than the old, entirely different design has been used in the construction of amplifiers for broadcast program work.

The main handicaps encountered in the older types of conventional amplifiers were the necessity for d-c operation of the filament, the use of a bulky and expensive plate-voltage rectifier, insufficient power output, limited frequency response, and difficulty in maintenance. The original design in circuit and mechanical construction was an outgrowth of the telephone repeater (amplifier) used by the Bell System in the Long Lines Department. During the past few years no particular effort has been made to depart from the con-

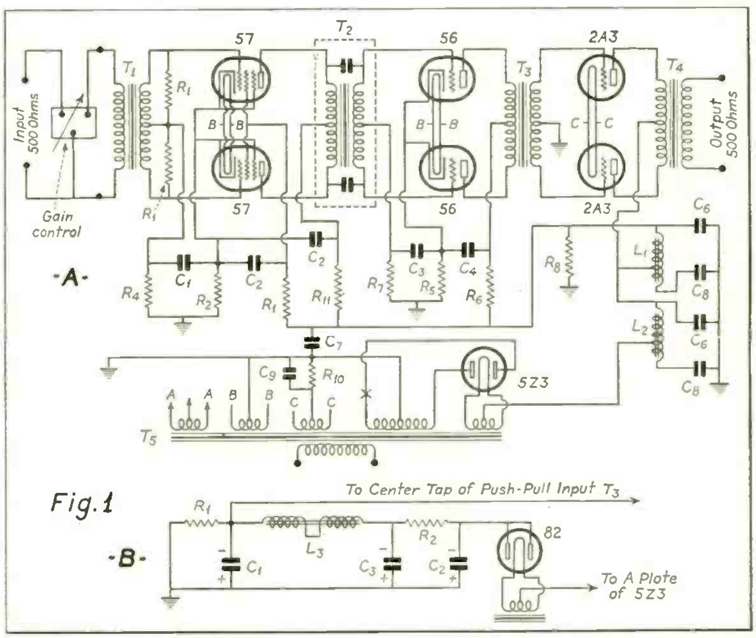
LEGEND FOR CIRCUITS OF AMPLIFIER, POWER SUPPLY AND C-BIAS RECTIFIER

R-1—250,000 ohm, 1 watt
R-2— 1,000 " 1 "
R-4— 50,000 " 2 "
R-5— 1,350 " 2 "
R-6— 5,000 " 2 "
R-7— 50,000 " 1 "
R-8— 50,000 " 25 "
R-10— 700 " 10 "
R-11—10,000 " 2 "
C-1—2 mfd, 200 volt
C-2—2 " 400 "
C-3—2 " 200 "
C-4—2 " 400 "
C-6—4 " 600 "
C-7—4 " 400 "
C-8—1 " 800 "
C-9—25 " 100 "

T-1—Input Transformer; 500 ohms input (Pri), 60,000 ohms each side of center tap on secondary.
T-2—Interstage Transformer; two screen-grid plates to two grids.
T-3—Interstage Transformer; two plates to two grids.
T-4—Output Transformer; two plates (2A3's) to line (500 ohms).
T-5—Power Transformer; primary tapped for 100, 110, 115, 125 volts, 60 cycles. Secondary, 425 volts each side of center tap at 150 ma; 2½ volts C. T. 5 A.; 2½ volts C. T. 3 A.; 2½ volts C. T. 14 A.; 5 volts C. T. 3 A.
L-1—Tapped filter choke; 40 henry, 60 ma; d-c res. 625 ohms.
L-2—Tapped filter choke; 15 henry, 120 ma; d-c res. 210 ohms.
L-3—Audio filter and parallel feed choke; 300 henrys, 3 ma; d-c res. 6,000 ohms.

Legend for C-Bias Rectifier

R-1—10,000 ohm, 2 watt
R-2—60,000 " 5 "
C-1—50 mfd, 100 volt
C-2—1 " 1,000 "
C-3—10 " 200 "



PROGRAM AMPLIFIER

FOR BROADCAST STATIONS

By LOUIS W. BARNETT, A.M.I.R.E.

STUDIO ENGINEER, WLW - WSAI

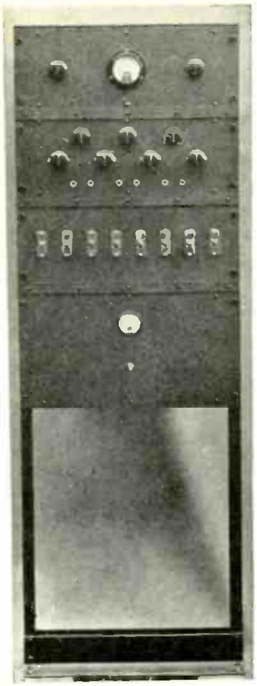


Photo courtesy of Mr. Glenn E. West, E. E. Dept., Purdue University.

FIG. 3-B. FRONT VIEW OF THE NEW DESIGN PROGRAM AMPLIFIER FOR BROADCAST STATIONS.

ventional design of speech-input amplifiers in developing equipment using all of the improvements made possible by the new tubes and modern circuits. New tubes and radically changed broadcast amplifier circuits brought about an ever increasing demand, among station engineers, for a new style amplifier embodying several much needed improvements.

NEW DESIGN

The latest type a-c tubes are used throughout in this program amplifier and in the rectifier. The entire tube alignment is in push-pull cascade. The first voltage amplifier stage uses two 57's in push-pull and is transformer-capacity coupled to the second stage. The second voltage amplifier stage employs two 56's in push-pull and is transformer coupled to the last (or power amplifier) stage. The last stage uses two 2A3's in push-pull. The bias rectifier uses an 82 full-wave rectifier tube and furnishes C-bias to all stages. The plate rectifier uses a 5Z3 full-wave rectifier tube in a very well-filtered unit providing a stable plate-voltage supply for the six amplifier tubes.

In designing high-quality rectifier circuits it has been found that a trap circuit, as shown in the power-supply circuit Fig. 1-A, results in appreciably higher filtering efficiencies. This is not necessary in all cases, but helps in cases of excessive hum.

The complete amplifier and rectifier circuit is shown in Fig. 1-A and the C-bias circuit in Fig. 1-B. The frequency curve is shown in the graph Fig. 2.

The wide frequency range of this program amplifier would have been considered impossible a few years ago. The characteristic curve shows the amplifier to be flat within plus or minus 2 db from 30 to 10,000 cycles per second. The excellent frequency response accomplished in this type amplifier (without the use of an equalizing network or padding filter circuit) is the result of new design employing very high-grade audio transformers, ideally built, very accurate values of impedance, capacity and resistance, and careful decoupling between stages. Due to the width of the passable frequency band, phase distortion is negligible at the high and low ends of the audio spectrum. The class A triode output stage will generate considerably less harmonic distortion than either a push-pull pentode or a Class B output stage.

POWER OUTPUT

The program amplifier, herein described, is capable of approximately 10 watts maximum undistorted output. However, the output power is proportional to the input power, so in broadcast work where the input volume is low, the output will never approximate the power value mentioned above. The maximum power output obtainable with fixed-bias is about 15 watts and with self-bias is about 10 watts, undistorted. However, due to the large amount of power output available (with suitable input signal) this amplifier is also well suited for driving recording heads for wax cutting, as a bridging amplifier, or as an audition or monitoring amplifier.

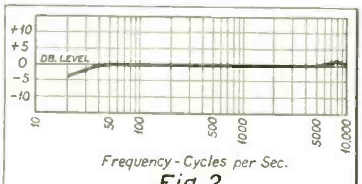


Fig. 2

FREQUENCY RESPONSE OF THE PROGRAM AMPLIFIER DESCRIBED IN THE ACCOMPANYING ARTICLE.

VOLUME-LEVEL CONTROL

No volume control is used in the secondary of the input circuit, because of evident complications; therefore, it is necessary to use a variable control for controlling the gain of the program amplifier. This, together with the circuit and legend for the 2A3 program amplifier, is shown in Fig. 1-A.

There is one point that must be kept in mind in building the power-supply unit. It must be well shielded to prevent any possible inductive hum pickup in the high-gain input-voltage amplifier. To use fixed bias, short out R-10 and return center tap of 2A3 filament winding to ground.

Fig. 3-A shows a program amplifier similar to the amplifier described in this article, with the exception that the one illustrated does not use push-pull first and second stages, and the single rectifier supplies both plate and grid bias. The general design of both amplifiers is the same in other respects.

Fig. 3-B shows a front-panel view of the same amplifier, with volume indicator (copper-oxide type), mixer panel, line selector keys, and power supply.

This equipment was built in the Electrical Engineering laboratory of Purdue University and was precision tested for performance.

WSVA

By

R.

C.

POWELL

PART II

MAIN RECEPTION ROOM. STUDIO DECORATIONS WERE PLANNED BY DOROTHY BABCOCK OF W. & J. SLOANE, NEW YORK.

IN LOCATING THE studios and offices of a broadcast station, it is the general practice to select a point which is most convenient for artists and salesmen. In the case of WSVA, which was to serve a dozen or more towns, the selection of the studio location presented an unusual problem. None of the towns in the proposed service areas were large enough individually to support the station. Each town is in competition with neighboring towns for tourist traffic, and sectional feelings make it impolitic to associate the station with any one community. This is a situation found in all parts of the country, but few stations have so many towns of equal size and importance to serve.

LOCATING STUDIOS

The choice lay between locating small studios in several of the larger towns, or picking the most central spot and branching out from there when business in any locality justified the expense of tying in an additional studio. Obviously some center of activities was needed, and as Harrisonburg was the most central, the main offices were located there.

After a search of the town for available space, the possibilities narrowed down to the three bank buildings. Two of these were six stories in height, each with a single elevator, and the third three stories high without elevator. It was felt that the traffic to and from the studios would at times seriously disrupt the elevator service to other tenants of the larger buildings and the building without the elevator was therefore selected. The floor plan of the space selected is shown. On the north side is a two-story building: the south and west sides face the two main streets of the town, and the noise from street traffic is considerable at all times. This rendered the windows useless for studio ventilation, as is usually the case.

LAYING OUT STUDIOS

In laying out the studios the traffic problem was given first consideration. There are three main groups of persons who frequent a broadcast station: those who visit to watch the broadcasting, the artists, and those who wish to do business with the station. Visitors are not interested in the offices and therefore may be confined to the reception rooms, leaving the balance of the space free for the use of those engaged in the station operation. Announcers must be in contact with their office, the control room, the artists and the studios. The arrangement shown was based on these considerations.

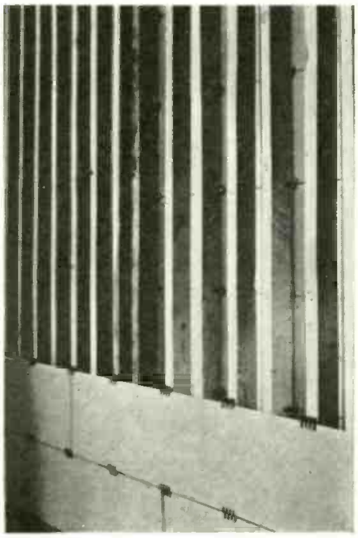
Where studios are located in an existing building, the ceiling height is a limiting factor in planning their size and proportions. The experience of a number of engineers has indicated that the best microphone pickup is obtained in studios having a certain relation between the length, width and height. Optimum ratios for studios of various sizes have been summarized in a group of curves.*

The best ratio of height, width and length may be roughly expressed as 2:3:5.

The effect of room volume has also been investigated with respect to the number of performers ordinarily present.*

*G. T. Stanton and F. C. Schmid, "The Journal of the Acoustical Society of America" --July, 1932.

SPRING SUSPENSION WALLS IN THE COURSE OF CONSTRUCTION.



● AN ACCOUNT OF THE ERECTION OF A REGIONAL BROADCAST STATION IN THE SHENANDOAH VALLEY, VA. --- CONTINUED FROM THE MAY ISSUE.

VIEW OF MAIN STUDIO FROM RECEPTION ROOM.

STUDIO DIMENSIONS

The regional broadcast station seldom has available large musical organizations which must frequently be accommodated in the studios. One studio for eight- or ten-piece orchestra and another suitable for soloists and small string groups is usually sufficient for the normal run of programs. The largest studio which might have been constructed with the existing ceiling height, adhering to optimum proportions, would have been 17 feet wide by 28 feet long. The volume of the above studio would be 5700 cubic feet, or sufficient to accommodate a group of eight persons.

As shown in the floor plan, the actual dimensions of the main studio were 29 feet 6 inches by 11 feet 9 inches by 16 feet. The smaller studio measures 10 feet wide by 19 feet 6 inches long. These dimensions are as close to ideal as circumstances ordinarily permit. The control room. located in the corner between the studios, gives the operator a satisfactory view of both studios and the windows between the studios and reception rooms give visitors a full view of the artists.

ACOUSTICAL TREATMENT

In the WSVA studios sound-proof construction was necessary because of the two studios adjoining and a business office on the floor below. The U. S. Gypsum Company spring clip and rock lath construction was found to be adequate and economical. A double spring mounted wall between the studios gave an attenuation of 60 db and a single spring wall gave a smaller, but adequate attenuation between the studios and surrounding space. The floors in both studios and control room were spring mounted.

A wide variety of acoustical materials is available for studio treatment. In general these materials have similar characteristics. Their porosity determines their sound absorption efficiency and their absorption at the lower frequencies increases with their thickness. The broad range of frequency response of modern sound equipment makes it imperative to consider the absorption efficiency of the sound treatment at the low frequencies as well as in the band between 256 cycles and 2048 cycles, in which absorption co-efficients are usually specified. As an example of the importance of low-frequency absorption, one of the smaller theatres which had been treated for the proper reverberation time at 512 cycles was found to be totally unusable because of a low-frequency rumble which was only eliminated after sheet rubber panels were placed in the walls to attenuate frequencies in the vicinity of 120 cycles. In the studio described here, U. S. Gypsum Company 1-inch Quietile was used on the walls and ceiling and the floor was made extremely resilient and covered with carpet.

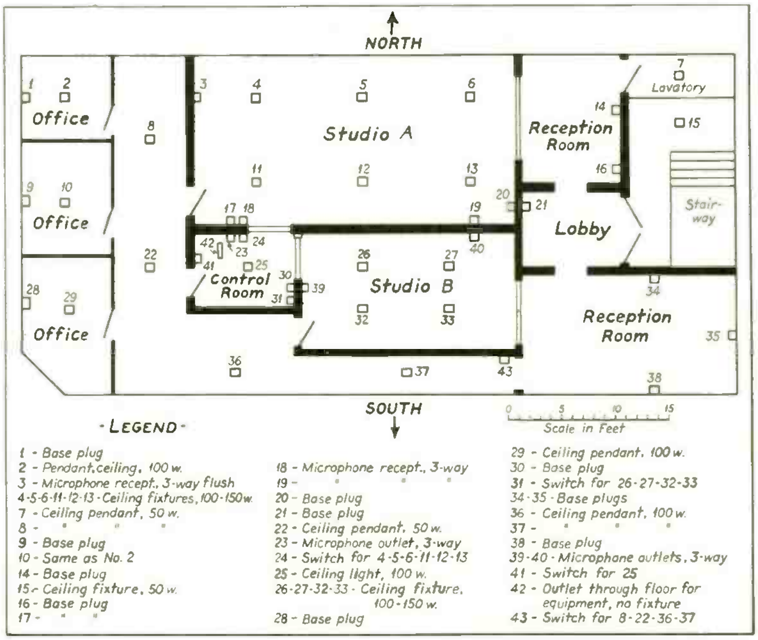
REVERBERATION TIME

Based on experience in the design and use in small studios, a reverberation time of .6 of a second in the large studio and .5 of a second in the small studio were believed to be satisfactory.

Using the well-known Sabine formula, the absorption of the large studio without treatment was found to be 82.3 units. To obtain the desired reverberation period, 397.7 units of absorption were required to be added. Carpet laid over half-inch ozite has an absorption co-efficient of .20. Deducting the co-efficient of the wood floor .06 gives a factor of .14. This, multiplied by the area of the floor, gives 67.2 units of absorption for the floor. One-inch Quietile with a sanded surface has an average co-efficient of .65 in the range between 128 and 2048 cycles.

Deducting the co-efficient of the untreated walls gave a co-efficient for the treated surface of about .60. To obtain

(*Continued on page* 18)



FLOOR PLAN OF WSVA BUILDING, HARRISONBURG, VA.

WISN STUDIO SOUND TRUCK

By N. J. RICHARD

STUDIO ENGINEER, WISN

THE FULL USE of all senses is essential in the everyday life and comfort of man; yet it may be said that of the five, the auditory and visual senses are prime.

In the theatre and on the stage the ear is aided by the eye. The voice of the actor is supplemented by facial expression and gesture which in turn are received by the ears and eyes of the audience.

In broadcasting, the ear is all-important. The auditory sense is relied upon or depended upon entirely.

The extent to which the broadcast listener of average intelligence will grasp the meaning or ideas embodied in a play or drama as it is unfolded before the microphone, depends not only on the voices of the dramatic group, but to the degree to which sound effects are employed to furnish atmosphere and background for the voice.

To overcome the inability on the part of the listener to use his sense of vision during the reception of a broadcast drama, sound effects are introduced at the studio as a form of compensation. In other words, sound effects are to broadcasting what scenery is to the theatre. With this in mind the author proposes to show how sound effects are produced and employed at WISN.

PROBLEMS

For several years, the production department felt the need of a system of sound effects readily accessible and easily operated as an aid to the proper production and rendition of programs and dramatic sketches.

Most of the sound effects used in the past were of makeshift material and unreliable. The problem of proper storage space for sound devices and their mobility from one studio to another became acute. Sound-effect recordings played an important role, but had to be carefully synchronized with the drama by the control operator, the turntables used being located in the control room. The proper rendition and synchronization of recorded sound effects from the control room was a major problem.

The disadvantage of such operation was two-fold. First, the control operator had a full-sized job to properly ride gain and mix the levels of the various microphones employed in the studio, without having to follow the script and watch for cues to fade in sound recordings and hold them to the proper level. Second, the dramatic group worked at a disadvantage and under a handicap when they were unable to actually hear the sound effects employed. The sources of potential error on the part of the control operator and the dramatic group were numerous and obvious.

EXPERIMENTAL TRUCK

To meet and partially counteract the above situation, an experimental sound-effect truck was constructed by the technical staff and has been employed the past two years. The sound-effect devices employed on this truck were electrically and manually operated, such as bells, buzzers, sirens, auto horns, etc.

The electrically (battery) operated sound-effect material was arranged in a convenient manner and operated by means of push-buttons and switches on a control box situated at one end of the truck. The truck was mounted on small castors to enable it to be moved about.

The author does not propose to include within the scope of this article a complete and detailed description of the experimental truck employed, other than to mention that with all its salient features the assets were offset by the fact that it proved to be bulky, heavy and hard to handle and move about. Above all, it lacked the most essential requirements; namely, turntables for recorded sound effects.

WISN now occupies the air seventeen hours a day and operates full time. Since it is an independent station and in no way connected with a network, it must fill its entire time locally. Station managers and production managers will appreciate the problems involved.

With the recent increase of daytime power and the increase to full-time operation, short plays, dramatic sketches and the drama play a major role in the program routine.

Past experience and present requirements quickly revealed the need and importance of a sound-effect truck that would incorporate the salient features of the experimental truck and one that would also include turntables for recorded sound effects.

ESSENTIAL REQUIREMENTS

The report of a preliminary study and survey revealed the following essential requirements and features to be embodied in the truck (in addition to turntables for recorded sound effects):

(a) Light weight.

(b) Sturdy construction.

(c) Portability (readily movable from one studio to another).

(d) All sound-effect devices integral with the truck to be electrically operated.

(e) The truck was to contain the maximum number of essential sound-effect devices consistent with its small size and light weight.

FIG. 1. TOP VIEW OF THE SOUND TRUCK. THE DEVICES ARE CONTROLLED BY PUSH-BUTTONS

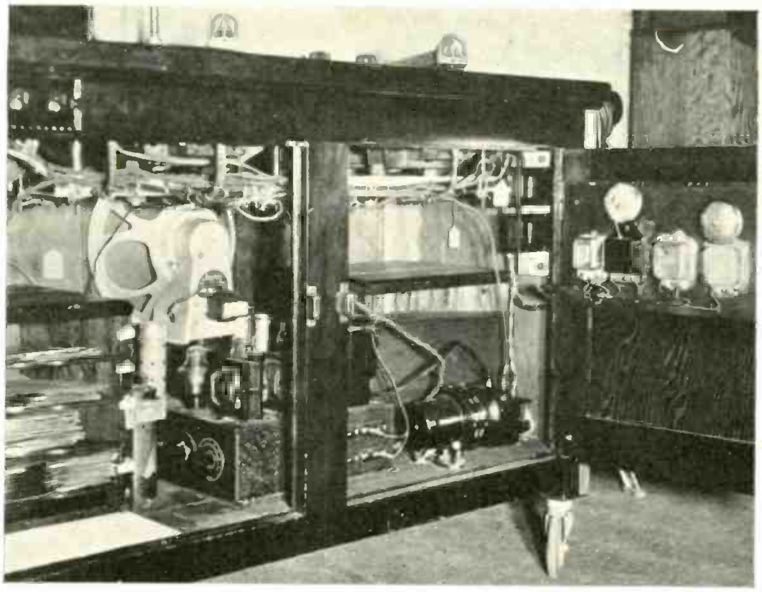


FIG. 2. INTERIOR VIEW OF SOUND TRUCK, SHOWING THE VARIOUS SOUND DEVICES.

(f) Shelf or cabinet space within the truck was to be provided for storage of sound-effect records.

(g) Provisions to be made for operation and control of electric motors, fans, wind machines, or whatever future requirements would indicate.

(h) Ease of operation.

(i) Neat appearance.

(j) Low cost.

The design and construction of such a truck was handled by the technical staff with the necessary cooperation of the production department.

GENERAL DESCRIPTION

The truck proper (exclusive of sound-effect devices) is built of redwood, rigidly reinforced by gluing all joints and by the generous use of small angle brackets. The paneling for the sides and ends is made of 3-ply veneer.

Light brass angle-strip is used on the corner posts to add protection and rigidity. Four-inch, ball-bearing, rubber-tired wheels are used to support the truck and to provide the required mobility. Internal shelf space on the bottom and at the two ends of the truck provide accommodations for 125 sound-effect records.

The entire truck is finished in dark walnut and the overall dimensions are as follows:

Length	54½ inches
Width	19½ inches
Height (without control box)	32 inches
Height (including control box)	36 inches

The accompanying photographs will serve to further illustrate the structure.

SOUND EFFECTS EMPLOYED

The sound-effect devices employed are as follows:

Manually-operated

1—Fire gong
1—Telephone ringer
1—Automatic telephone dial
Chinese cymbals (various sizes).

Electrically-operated

1—Auto horn (bass)
1—Auto horn (tenor)
1—Motor-driven siren
1—Doorbell, a-c operated
1—Doorbell d-c operated
1—Buzzer a-c operated
1—Buzzer d-c operated.

OPERATION AND CONTROL

Provision is made for the operation and control of an electric fire gong and telephone ringer to be installed in the near future.

Control of the above sound devices is accomplished by means of push-buttons arranged on the control panel as shown in Fig. 1. The key switch and three binding posts situated in the lower left-hand corner of the control panel provide means for the connection and control of a standard cradle telephone to the amplifier for rendering realistic telephone conversations before the microphone.

In the control of electrically-operated sound devices in the studio, it is quite important that silent switching takes place (the snap of toggle or button switches would be readily picked up by the microphone and in most cases would not be desirable). To accomplish the silent switching of electric motors, wind machines, fans, etc., not associated directly with the truck, knife switches are used, the handles of which are shown protruding through slots in the center of the control panel, Fig. 1.

Electric service (110 volts, a-c and d-c) is furnished the truck from convenient service outlets in the studio by means of two 20-foot, 2-wire rubber-covered cables. When not in use, these cables are wrapped around the end handles of the truck.

Master control switches located on one end of the truck serve to disconnect all electric service to and within the truck. This serves to prevent operation of the truck by people not familiar with it.

The motors for the turntables are of the induction, 60-cycle disc type, rotating at 70 rpm. Like all induction machines of that type, they are capable of running at 156 rpm by merely spinning the disc with the hand until the double

FIG. 3. THE SOUND TRUCK IN ACTION: THE AUTHOR AT THE CONTROLS.

1935 ●
BROADCAST ENGINEERING

speed is attained. Weird and novel sound effects can be produced at such speed. The motors are individually con-

in ways other than will be described here.

Tone and volume controls are pro-

CONCLUSION

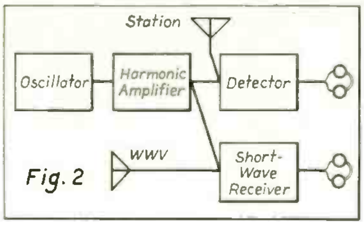
An adjustable music rack is provided for the script as shown in Figs. 1 and 3.

the dial for the calibration point. It may be seen that. when the vernier dial is first set to 2413.793 kc, and the oscillator is standardized by an auxiliary condenser exactly against WWV, the dial will then read directly the station frequency when turned to zero beat on the transmitter. Instead of marking the actual values of frequency on the dial it is more convenient to index in cycles deviation, making the point at the center—corresponding to exact station frequency—read 0, and running up to 1000 cycles or so on either side.

SOURCES OF ERROR

The possible sources of error in this method of measurement lie in the calibration of the vernier dial, and in oscillator drift during the interval between standardizing on WWV and measuring on the station. The effect of the first error can be made small, chiefly because it has to do with the deviation figure rather than with the station-frequency figure. In other words, on a 1000-0-1000 deviation dial the marking can be off 1 percent and yet cause an error of no more than 10 cycles in the station-frequency reading.

By proper circuit design and choice of component parts, by stabilizing anode



BLOCK SCHEMATIC OF APPARATUS LAYOUT FOR CHECKING FREQUENCY WITH WWV.

voltages with a neon regulator tube and filament voltages by means of storage-battery supply, an exceptionally high order of frequency stability in the harmonic oscillator can be attained over short periods of time. After these precautions are followed, temperature remains a major factor affecting stability, and the oscillator needs to be operated for an hour or so to reach temperature equilibrium before being used to highest accuracy. Repeated tests in the laboratory and in practice have demonstrated that accuracies to within 0.001 percent are readily attained by this method of measurement.

LAYOUT OF APPARATUS

In Fig. 2 is shown a block schematic of apparatus layout for the method. The harmonic oscillator employs a type 36 screen-grid tube in the electron-coupled circuit with an Isolantite-form inductance and precision condenser in the tank circuit. An amplifier functions to bring up the level of the 5000-kc and the station-frequency harmonics of the oscillator, and a detector for listening to zero beat on the local transmitter is provided.

It might be noted that the method is just as applicable to measurement of a distant transmitter as to a local transmitter—by picking up the former in a receiver and heterodyning against the output of the frequency meter. The convenience and direct readings of the method lend favorably to measurement of any single-frequency chain of transmitters from a central point.

APPLICATIONS

Allowing for minor exceptions, the method is applicable to any channel from 1500 upwards to around 23,000 kc. With slide rule and log tables, the arithmetic can be performed in short order to find a low frequency for the oscillator which will fit WWV and any station-frequency channel. The exceptions lie in a narrow region on either side of frequencies integrally related to 5000 kc. For all other channels an extremely simple and accurate means of frequency measurement is made available.

WSVA

(*Continued from page* 13)

the additional 330.5 units of absorption required the application of approximately 550 square feet of tile. A modified live-end, dead-end arrangement was used, the wall at the microphone end of the studio being completely covered with tile. One side wall adjacent to this end is covered solidly for a distance of 8 feet from the end and the opposite wall for a distance of 6 feet from the end. The balance of the tile was applied in staggered two-foot pilasters along the side walls. The balance was applied in a panel in the center of the ceiling. With this arrangement there were no hard plaster walls opposite and no path of direct reflection between hard plaster walls from the program source to the microphone. In the small studio, where the artists are usually grouped in the center of the room, the sound treatment was applied in rectangular panels on the walls and ceiling. One end was completely covered with tile.

LIGHTING

For reading music and script, a light intensity of 10 to 12 foot-candles is the minimum desirable. The studio lights were arranged to give maximum illumination in the areas usually occupied by the artists. The formula for calculating light intensities is found in all lighting fixture catalogs. It involves the size of the lights, their spacing, type of shade used, the color of reflecting surfaces and the level at which the light is used. Direct lighting is preferable in studios which are to be air conditioned, because more light is obtained for a given amount of heat generated. Five 200-watt lights were used in the large studio, four in the small one. Base plugs were provided for photographic work and special lighting effects.

(*To be continued*)

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BYRD EXPEDITION AND RADIO

AMONG THE MORE important opportunities presented by the Byrd Expedition was an unusual chance for achievement and study in the field of short-wave radio communication.

Mr. Clay Bailey, Chief Radio Operator of the Expedition, and Mr. A. Y. Tuel, Vice-President and General Manager of the Mackay Radio and Telegraph Company, believe that in their eighteen months of radio operations between the Mackay Radio stations and the Expedition, a large part of which were over a span of 9,000 miles, they have given short-wave radio its greatest test—a test which was met with a consistently reliable performance. Communication between the Expedition and civilization was practically unimpeded during the entire period, and it is, of course, true that not only the safety of the Byrd Expedition but its aims, purposes and achievements as well depended upon reliable communication.

No special equipment nor special installations of any kind were employed for this unusual communication service. The equipment aboard the *S.S. Jacob Ruppert* and *Bear of Oakland* was standard Mackay Radio shipboard transmitting and receiving equipment and the coastal stations of Mackay Radio at Sayville, L. I. (WSL), and Palo Alto, Calif. (KSF), had the super power necessary to maintain contact with Little America.

The coastal stations at Sayville and San Francisco are directly linked together by Mackay Radio high-speed radio-telegraph circuits. It was therefore possible for these stations to intercommunicate quickly and easily with one another, and by means of traffic control to route the outgoing messages.

After the completion of the Little America station, KFZ, communication was established with Sayville and San Francisco. Severe demands were placed on all three stations because of the necessity for KFZ to occupy the dual role of both a point-to-point and a broadcasting station.

The HIGH-QUALITY Problem

Check These Points for High-Quality Broadcast Transmission

By J. A. HUTCHESON
Radio Engineer
WESTINGHOUSE ELEC. and MFG. COMPANY

TODAY, ONE OF the most interesting and important questions that is the subject of much discussion in radio engineering circles concerns what must be done to insure high quality. This question really asks "what variations in the transmission of a band of frequencies can be allowed and what are the limits of this band?—to what extent can broadcasting equipment distort the incoming program before the listener will notice distortion?"

THE HIGH-QUALITY PROBLEM

Probably the only correct answer to this question would be that there must be no variations in transmission of any of the frequencies capable of being heard by anyone, and that the equipment must reproduce accurately and without distortion of either the amplitude or phase relation, any of the components which go to make up the complicated structure of speech or musical sound waves. While this system is ideal it is far from practical. Fortunately the human ear is quite lenient in some ways and allows certain liberties in a transmission system which greatly simplifies the problem and yet does not produce differences noticeable to the average listener.

In an effort to define the limits which a system must meet it is necessary to first define the problem. One simple and yet rigorous definition is that the sound waves produced by the system must sound the same to the average ear as do the sound waves which are being picked up by the apparatus. Since sound waves are at the bottom of the task it is logical to investigate to what extent the average ear can detect alterations in a sound wave. Scientific results of this problem are well known, and can be used to express the tolerances to determine the limits to which a system must be confined.

To start with, the problem divides itself naturally into three questions:

1. What frequency range exists in speech and music and to what extent does the ear respond to these frequencies?
2. How much can the relative phase of the component frequencies be altered?
3. How much amplitude distortion can be tolerated?

FREQUENCY RANGE

The answer to the first question is quite well known. The lowest fundamental frequencies are found in music and are the lowest notes of the pipe-organ and piano. The lowest note of the largest pipe-organ is about 16 cycles, while the lowest note on a piano is about 26 cycles. The highest fundamental tone is that of the piccolo at about 4300 cycles. The highest note on the piano is 4096 cycles. However, in the case of high frequencies the tones produced by the various high-pitched instruments, such as the flute, violin, piano and piccolo, are complex tones possessing a relatively large amount of harmonic power so that the upper frequencies heard by the human ear are in the order of 15,000 cycles or higher.

The human ear responds to frequencies in the order of 16 cycles to 17,000 cycles. Lower or higher frequencies produce an effect which is noticeable by a sense of feeling rather than by the sense of hearing. The response of the ear over its frequency range is not uniform; that is, sound waves possessing constant amounts of power, but varying in frequency, do not produce equal effects on the listener.

This is best illustrated by studying the power required to produce a barely audible sound of a given frequency. Starting, for convenience, at 64 cycles, it varies as follows: At 64 cycles the amount of power required to produce an audible signal is 35 microwatts; 128 cycles, 1.06 microwatts; 2048 cycles, .0004 microwatt; and at 16,384 cycles, 41 microwatts are required. Thus the ratio of the power required to produce a barely audible tone at 64 cycles to the power required to produce a barely audible tone at 2048 cycles is 90,000 times. Expressed in voltage or sound pressure the ratio would be 300. The ear is most sensitive to frequencies in the range of 1000 to 4000 cycles.

As might be expected from this, it has been found that the ear does not

● **Some pointers on frequency-range requirements, phase shift in terms of time delay, permissible distortion, and percentage of modulation in relation to audio frequencies.**

respond uniformly to changes in intensity of sound waves of varying frequency. For example, at a level of 10 db above the minimum perceptible sound level the intensity of a sound wave of a frequency of 1000 cycles may be varied 73 percent to give a barely noticeable change in intensity. Similarly, the intensity of a sound wave of 60-cycle frequency may be varied up to 250 percent to give a barely perceptible change in intensity. However, if the level of the sound is increased, the minimum perceptible change in intensity is lowered. Thus when the level is increased up to an intensity corresponding to one microwatt flowing through one square centimeter area, a value, incidentally, corresponding to the average level which flows from the mouth when speaking, the minimum perceptible change in intensity level, expressed in decibels, varies from 3 db at 30 cycles to 0.22 db at 2000 cycles. At a frequency of 8000 cycles an intensity change of 0.5 db is noticeable.

PHASE SHIFT

The problem of phase shift of the various frequencies in a complex sound wave is of little importance to the designer of broadcast transmitters or receivers. It has been demonstrated that it is possible to shift the phase of any of the components of a complex wave without altering the effect on the ear. This means that the ear does not respond to wave shape of a complex tone, but rather is actuated by the individual component pure tones.

However, there is one way in which phase shift, or to put it in another way, time delay, does enter into the picture. When the transmission is carried over lines of considerable length, it is found that the high frequencies require a longer time to traverse a given length of line than do the lower frequencies, because of the propagation characteristics of the line. For example, when speaking over a long-distance telephone line which has not been corrected for this effect, any switching click in the line sounds more like an ascending whistle than a click. The click can be resolved into a low frequency and an almost limitless number of harmonics of the fundamental low frequency. Then, due to the line characteristics, the harmonic frequencies arrive at the receiving point later than the fundamental, each higher harmonic being delayed more than the preceding one. As the pure tones are of a transient nature, it is possible to arrive at the condition where first the fundamental is heard, then the second, third, fourth harmonic, and so on, giving rise to the ascending whistle. This problem is being solved by the application of delay networks whose delay characteristic is the complement of the delay characteristic of the line with which they are associated.

AMPLITUDE DISTORTION

The question of amplitude distortion is without doubt the one which will claim the most attention in the immediate future. At the present time very little is known regarding the ability of the ear to perceive change in the character of a tone as the amplitude of the harmonic components is altered or as other harmonics are introduced. It has been demonstrated that it is possible to detect and identify by ear harmonics whose amplitude is less than one-half of one percent of the fundamental amplitude.

The effect of the harmonics is to alter the character of the tone. They do not affect its pitch or intensity, but change it in a manner to make it sound different. For example, a tone possessing a number of high-order harmonics of relatively large amplitude will sound harsh and irritating. Another way in which distortion affects complex tones is explained by the relative phase of harmonics existing in the original tone and harmonics added by the transmission system. Thus a harmonic added by the transmission system may be so phased as to add to or subtract from a harmonic existing in the complex tone being transmitted.

It is a well-known fact that the character of a complex tone which allows differentiation between various speaking voices or between different musical instruments playing the same tone, is determined by the harmonic content of the complex tone. Change in amplitude of the harmonics alters the character of the tone. This possibly accounts for the expression so often heard in the early days of broadcasting, "He sounds so different over the radio." Unfortunately, this remark is still heard.

AMOUNT OF DISTORTION

The amount of distortion which can be tolerated in a transmission system is still largely a matter of opinion. Probably the designers of equipment are their own severest critics, as it seems that one who is engaged in the task of eliminating distortion from transmission systems becomes more sensitive to a slight amount of distortion than the average listener. A few general conclusions relative to allowable distortion can be drawn from experience. For example, it is known that if a second harmonic be added to a pure tone, the character of the tone is changed only in a slight degree. Thus it is possible to add harmonics which are one or more octaves higher than the fundamental without seriously altering the character of the tone.

However, odd harmonics and even harmonics which are not octaves of the fundamental noticeably alter the character of the sound. Therefore, it may arbitrarily be said, that the percentage of second and fourth harmonics that can be tolerated is greater than the percentage of third and fifth, for example. The absolute value of tolerable harmonic will vary with the fundamental frequency. This is partially obvious at least. For example, so far as transmission quality is affected we could tolerate 100 percent second harmonics on a fundamental frequency of 10,000 cycles as the second harmonic frequency would be inaudible.

AUDITORY TIME DELAY

Another important characteristic of the human ear, which bears on the question of distortion, is the apparent time required for the ear to detect the presence of tone. Investigators have found that a rather definite time is required to excite the ear in order that the sense of tone having a definite pitch will be established. The data available are limited but indicate clearly that this time-delay response is a fact. Measurements have been made which show that this time is more or less independent of frequency. For example, a tone of 128 cycles requires .0946 second to excite the ear; one of 384 cycles requires .0627 second, and one of 512 cycles requires .0579 second. If the loudness of the tone is increased, the time required is lessened by about 75 percent of the values quoted above. This means that if we allow distortion to occur during relatively short intervals of time, say less than 40 milliseconds, the ear will not detect the presence of the harmonics.

This particular faculty of the ear tolerates transmission systems wherein the distortion is low for the average level of transmission and increases as the level is increased. It is well known that the level of certain types of speech and music is normally quite low but has relatively high peaks which are of short duration. If the system does distort during transmission of these momentary peaks, the distortion components do not exist a sufficient length of time to allow the ear to perceive them.

Two important characteristics of a high-quality broadcast transmission system can be determined by a consideration of the foregoing material.

AUDIO CHARACTERISTIC

First the audio-frequency response characteristic can be defined as follows: With reference to a straight line the response at 50 cycles should not vary more than plus or minus one and one-half decibels; at 150 cycles it should not vary more than plus or minus six-tenths decibel; at 2000 cycles, plus or minus a quarter of a decibel; and at 8000 cycles, plus or minus one-half decibel. A characteristic within these limits will assure completely satisfactory response in that the listener will not be able to detect any change in the intensity of the various component frequencies in the received signal as compared to the transmitted signal.

MODULATION

By virtue of the fact that time is required for the ear to determine the existence of a sound wave the station can allow over-modulation of a transmitter for short intervals, say for twenty to forty milliseconds, without appreciably altering the character of the transmitted signal, because the harmonic components generated in this short time will not exist long enough to affect the ear. This allows the transmitter to be operated at a higher average level of modulation resulting in increased service area.

CONTRIBUTING FACTORS

Any requirement regarding distortion must of necessity be based on experience in the field rather than laboratory experiments merely because such experiments have not as yet been carried out. To arrive at such arbitrary requirements one must take into account several contributing factors. For example, the difference in power existing in tones of differing frequency must be recognized. Tests were made recently to obtain a rough idea of the extent of this variation. Perhaps the most consistent and readily measurable musical instrument is the pipe-organ. Using one stop on the great organ, namely, the eight-foot "Gross Flute" stop, measurements showed that whereas a tone whose fundamental frequency was 60 cycles would modulate a transmitter 100 percent, another tone whose frequency was 1800 cycles would modulate the transmitter only 10 percent. Similar data were taken on several other stops.

It is believed that this is true of music in general: that is, the energy in the low notes is from several hundred to several thousand times as great as the energy in the high notes. An interesting check of this was made using a cathode-ray oscillograph to observe waveform. A chord was played on the organ using the full organ. The wave-shape was observed and then all component notes except the lowest pedal note were released. The only change in wave-shape was that the wave instead of being serrated was smooth. Its general form was unchanged and its amplitude did not vary more than 10 percent.

CONCLUSIONS

This fact must be taken into account in design of broadcast transmitting equipment so as to insure distortion-free transmission, particularly at the low-frequency end of the audio band, say from 50 to 200 cycles. It is believed that this band is the one in which old-time transmitters possessed a fairly high percentage of distortion, thereby causing the well-known type of distortion which resulted when the program possessed a relatively large amount of low frequencies. Another reason for paying special attention to distortion at low frequencies is that the effect of the harmonics is increased by the increasing sensitivity of the ear up to frequencies in the order of 2000 cycles.

It is believed that future requirements regarding distortion will include weighting factors which will tend to assign a value to a harmonic which depends on its frequency and the fundamental frequency also.

Distortion at high frequencies is relatively unimportant so far as the ear goes, but becomes extremely important when considering adjacent channel interference. In this case the higher harmonics spread out, as it were, into a band of frequencies being utilized by another transmitter and produce interference with another program.

As shown in tests just described, the effective percentage of modulation produced by tones of approximately even loudness but varying in frequency, decreases as the frequency is increased. These data were analyzed to find a relation between the amplitude of tones of equal loudness and the frequency of the tones. An approximate formula expressing the results of this analysis is:

$$A = \frac{B}{f.5}$$

where A is the amplitude, B a constant and f the fundamental frequency. It is reasonable to assume that the effect of a harmonic of one tone on the fundamental of another tone which is a multiple of the lower tone is related to the ratio of the amplitude of the higher tone to the amplitude of the harmonic of the lower tone. If it is assumed that the expression involving amplitude and frequency is reasonably accurate, the formula for expressing the allowable effect on higher frequencies is:

$$D \times \left(\frac{f_n}{f_o}\right) .5 = C$$

where D is the percentage of the harmonic in terms of the fundamental amplitude, f_n is the frequency of the nth harmonic, f_o is the frequency of the fundamental, and C is the ratio expressed in percent of the actual amplitude of the harmonic of f_o to the amplitude of another fundamental frequency which is n times the lower tone f_o. Thus in order to limit distortion to an amount which bears a constant relation to the amplitude of other high frequencies, multiply the absolute percentage of harmonic by the square of the order of the harmonic.

SPECIFYING REQUIREMENTS

As a temporary weighting means for specifying harmonic distortion the following scheme is proposed: For frequencies from 50 to 1000 cycles, the absolute percentage of distortion in terms of the fundamental should be multiplied by the square root of the number of the harmonic. This product then should not exceed 2.5 for any individual harmonic up to 65 percent modulation and should not exceed 5 up to 100 percent modulation. For frequencies in excess of 1000 cycles, it is recommended that the absolute value of any harmonic be held below 2 percent up to 50 percent modulation and 5 percent from 50 to 100 percent modulation. It is believed that this is not only satisfactory but also readily obtainable in present-day equipment.

Two other requirements which can be specified without reference to the effect on the ear are the residual carrier noise level and the volume range of the equipment. Considerable data has shown that even in the most quiet homes the noise level is only from 40 to 50 db below a comfortable signal level from the receiver. Consequently, if the residual noise is 50 db down from the 100 percent modulation level this sound can be expected to be masked by the noise existing in the home. This automatically limits the volume range also to about 45 decibels.

It should be borne in mind that these requirements apply to the complete transmission system from microphone to antenna. The old proverb that a chain is only as strong as its weakest link certainly applies to the problem of high-quality broadcasting. The system will be no better than its worst amplifier and a bad tube in an insignificant, even invisible, amplifier can completely ruin an otherwise excellent apparatus.

AIR MASS DATA BY RADIO

AN OCTOPUS-LIKE system of teletype lines and radio channels, tapping the 25 cities on the 3,755-mile Eastern Air Lines routes, is centered in the weather-operations office of the airline at Washington, D. C., comprising the elaborate new weather department which operates 24 hours of the day, out-guessing nature in all her angry moods.

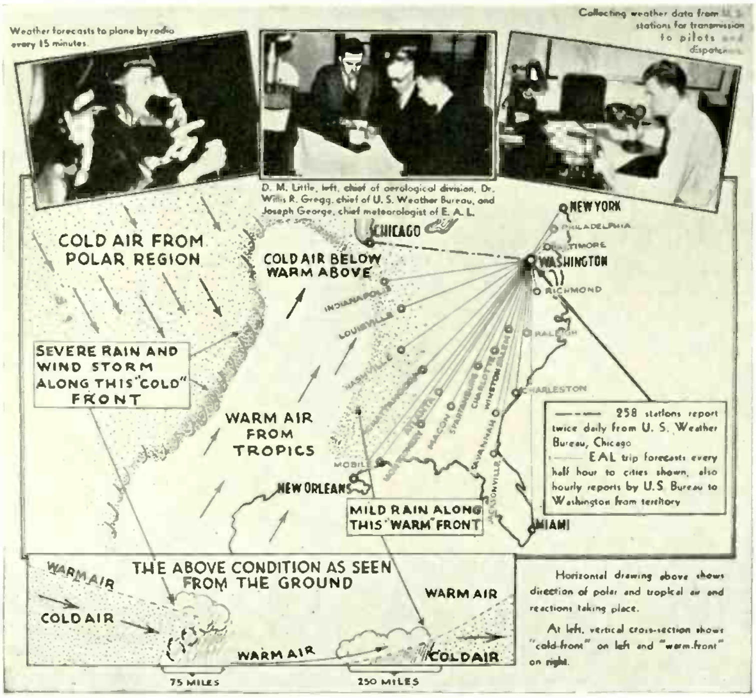
The Air Mass Analysis System of weather forecasting, proved practical for airline operation only a few years ago on the Pacific Coast, has been instituted by Joseph George, chief meteorologist of Eastern Air Lines. In 1932 he collaborated with scientists of the California Institute of Technology in testing the method over a western airline.

The communication tentacles of the company weather bureau follow the three great air routes of Eastern Air Lines: New York to Miami, New York to New Orleans, and Chicago to Miami. Weather information is not only received by teletype and radio from the 15 states served by the airline, but two general and 46 trip forecasts are issued from the "octopus-like brain" during the 24 hours, or practically one every one-half hour.

In the general forecasts sent to every station at 9:30 a. m. and 9:30 p. m., the Eastern Air Lines Air Mass forecasts advise what trips will complete or cancel and where delays will occur before the weather clears. The special trip-forecasts are sent to pilots and dispatchers an hour before scheduled departures at the six major terminals so that a study can be made before any particular flight takes off.

Supplementing hourly reports from various eastern points, the United States Weather Bureau also supplies the Eastern Air Lines Weather Bureau with two general weather reports from the 250 major weather bureau stations as far north as Point Barrow, Alaska, Canadian stations, and 10 ships at sea in the Atlantic Ocean. These reports are received at 8:25 a. m. and 8:25 p. m.

On December 1, 1933, President Roosevelt's Science Advisory Board recommended provisions that would extend the Air Mass analysis method over the United States through cooperation of the Weather Bureau with the Army and Navy Air Services. Twenty-two upper air soundings are now being made at various sections of the country by airplane to obtain upper air information of great importance to the United States Weather Bureau and the Eastern Air Lines weather department in forecasting by Air Mass Analysis.



THE AIR MASS ANALYSIS SYSTEM NETWORK CONNECTING THE TWENTY-FIVE CITIES ON THE EASTERN AIR LINES ROUTES, AND CENTERING IN WASHINGTON, D. C.

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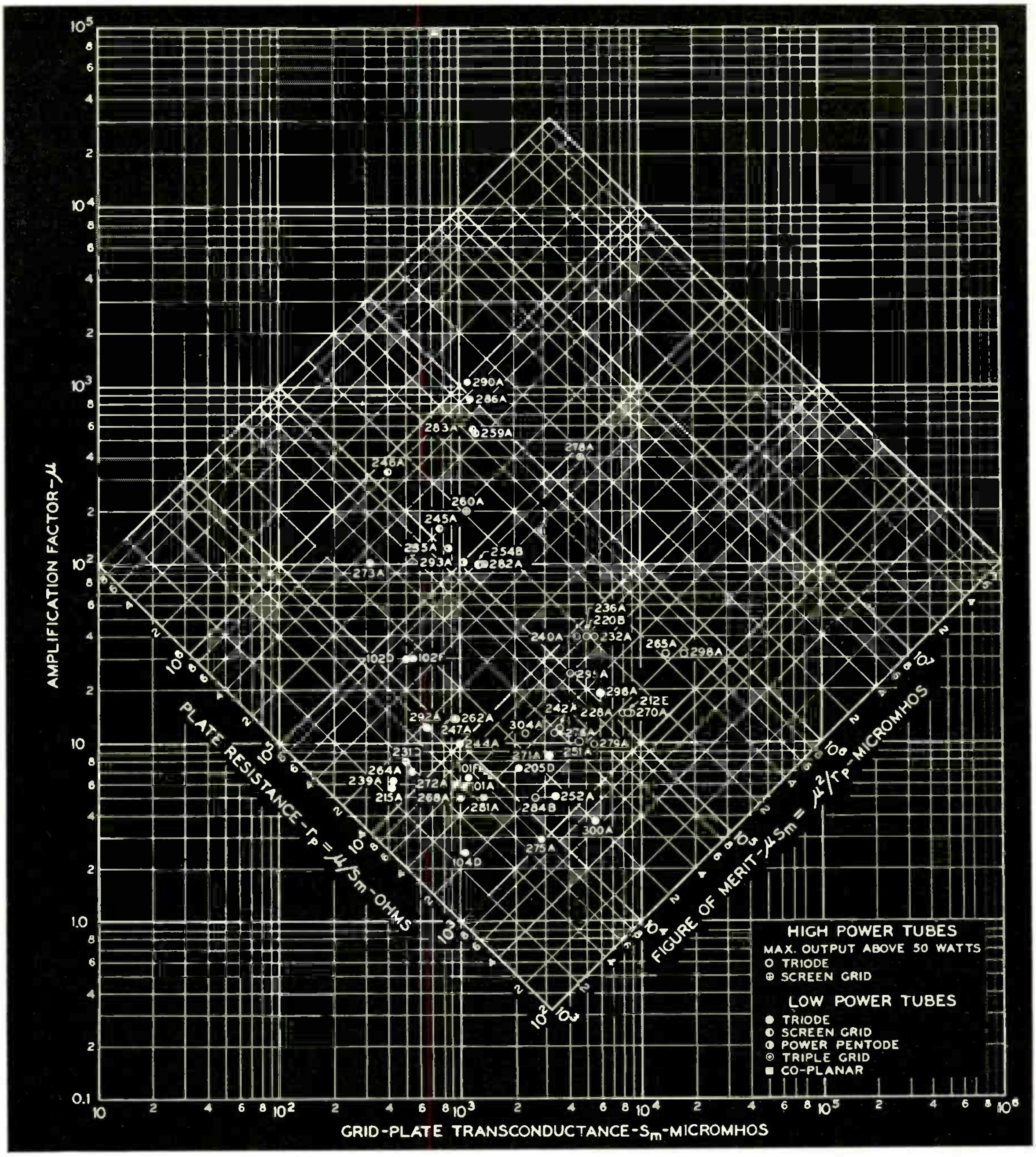
RCA TELEVISION FIELD TESTS

PLANS FOR RCA's field test of high-definition television to begin some time next year are being developed under the direction of an inter-company committee named today by David Sarnoff, President of Radio Corporation of America.

The committee, headed by Dr. W. R. G. Baker, vice-president and general manager of the RCA-Victor division of RCA Manufacturing Company, Inc., will draw on the broadcasting, communication and manufacturing experience and resources of RCA in formulating the details of the field test. Five other leading authorities on radio and electronics who will serve with Dr. Baker in constituting RCA's Television Committee, are R. R. Beal, RCA research supervisor; C. W. Horn, director of research and development, and O. B. Hanson, chief engineer for the National Broadcasting Company; C. H. Taylor, vice-president in charge of engineering for RCA Communications, Inc.; and J. C. Warner, vice-president and general manager of the Radiotron division of RCA Manufacturing Company, Inc.

In a statement May 7 announcing RCA's plan to conduct a field test on high definition television, Mr. Sarnoff pointed out that from 12 to 15 months would be required for the construction of a transmitter and experimental receiving sets, and that then RCA would be in a position to test television possibilities under actual operating conditions.

CHARACTERISTICS OF WESTERN ELECTRIC VACUUM TUBES



THIS MONOGRAM, PREPARED BY G. L. PEARSON, IS ANALOGOUS TO ONE FOR CIRCUIT PROBLEMS INVOLVING FREQUENCY, REACTANCE, CAPACITY AND INDUCTANCE, DESCRIBED BY T. SLONCZEWSKI IN THE BELL LABORATORIES RECORD, FOR NOVEMBER, 1931. HAVING PLOTTED THE AMPLIFICATION FACTOR AS ORDINATE AND THE GRID-PLATE TRANSCONDUCTANCE AS ABSCISSA, THERE IS A POINT ON THIS CHART FOR EVERY VACUUM TUBE. SINCE PLATE RESISTANCE r_p IS THE RATIO OF THESE TWO QUANTITIES, ONE OF A FAMILY OF DIAGONAL LINES WILL INDICATE THE VALUE r_p FOR ANY TUBE.

Federal Communications Commission Reports

CHANGES IN RULES

THE COMMISSION on May 22, 1935, changed its allocation in Rules 229 and 275 B so as to make the frequencies 4175 and 4180 kilocycles available for coastal telephone stations only. Therefore, since these frequencies are no longer available for use by coastal telegraph stations they should be deleted from Rule 275 A.

The Commission on June 12, 1935, modified Rule 229 to read in part as follows:

5705 kc 5710 kc	} 5707.5 kc, aviation

The Commission on June 18, 1935, modified Rule 262 (a), B, to read in part as follows:

Eastern Continental Chain and Feeders (Green)

Available for aeronautical and aircraft stations

2854 kc	4122.5 kc
2922 kc	5652.5 kc
2946 kc	5707.5 kc*
2986 kc	

*Day only, not to be used within 400 miles of Canada.

Available for aeronautical point-to-point stations

2608 kc	6590 kc—Day only
2748 kc	6600 kc—Day only
4745 kc	

The Commission on June 19, 1935, modified Rule 229 as follows:

5165 kc—Aviation.

The Commission on June 25, 1935, modified Rule 245 to read as follows:

"The term 'aeronautical station' means a station used primarily for radio communication with aircraft stations, but which may also carry on a limited fixed service with other aeronautical stations in connection with the handling of messages relating to the safety of life and property in the air."

The Commission on June 25, 1935, modified Rule 262 (a), B, to read in part as follows:

Southern Intercontinental Chain and Feeders (Orange)

Available for aeronautical and aircraft stations

2870 kc	5405 kc—Day only
2986 kc*	5692.5 kc
3082.5 kc	6570 kc
5165 kc**	8220 kc
5375 kc	12330 kc
	16440 kc

*Available for use in the Pacific area only.

**This frequency is assigned upon the express condition that no interference will be caused to the international service of any station which, in the discretion of the Commission, may have priority on the frequency or frequencies with which interference results.

Available for aeronautical point-to-point stations

2648 kc	6580 kc—Day only
2986 kc*	8015 kc
3082.5 kc	8220 kc***
5165 kc**	12330 kc***
5375 kc	16240 kc
6570 kc—Day only	16440 kc***

*Available for use in the Pacific area only.

**This frequency is assigned upon the express condition that no interference will be caused to the international service of any station which, in the discretion of the Commission, may have priority on the frequency or frequencies with which interference results.

***These frequencies are assigned for secondary use upon the express condition that no interference is caused to the international mobile service.

CHANGES IN AMATEUR REGULATIONS

THE TELEGRAPH DIVISION on June 18 made the following changes in the amateur regulations:

1. *Rule* 376. Change "28,000 to 28,500 kc" to read "28,000 to 29,000 kc."

Reason: There is an increased amount of activity in the amateur band 28,000 to 30,000 kc and much of it by voice communication. At present, only the portion 28,000 to 28,500 kc is available for amateur radio telephony. The effect of the change is to assign one-half of this amateur band for amateur telephone use in addition to amateur radio telegraphy.

2. *Rule* 382. Change the stipulated frequency in Rule 382 from "14,400 kc" to read "30,000 kc."

Reason: It is believed that the work in the 28,000-30,000 kc band has now passed the experimental stage where it was unwarrantable to permit unstable signals and any form of plate supply as an aid to rapid development. It is now requested that direct-current plate supply (for the purpose of minimizing instability, etc.) be required in that band in the same manner as it is on amateur frequencies below 14,400 kc.

3. *Rules* 368 and 387. Wherever the stipulated frequency "56,000 kc" appears in Rules 368 and 387, change to read "28,000 kc."

Reason: There is considerable amateur interest in being permitted to engage in portable-mobile operation in the 28,000-30,000 kc band on the same basis as is permitted under present regulations on frequencies above 56,000 kc. These frequencies share with the higher frequencies the characteristic of being in a region not commonly employed by the commercial classes of service where interference would not be at all likely to ensue. Amateurs have found the performance of frequencies in the 28,000-30,000 kc band extremely variable and it is believed that if this band were made available for portable-mobile operation, a great deal more would be learned of the characteristics of this band.

4. *Rule* 381. It is recommended that the following be substituted for the present Rule 381.

"Spurious radiations from an amateur transmitter operating on a frequency below 30,000 kc shall be reduced or eliminated in accordance with good engineering practice and shall not be of sufficient intensity to cause interference on receiving sets of modern design which are tuned outside the frequency band of emission normally required for the type of emission employed. In the case of A3 emission, the transmitter shall not be modulated in excess of its modulation capability to the extent that interfering spurious radiations occur, and in no case shall the emitted carrier be amplitude modulated in excess of 100 percent. Means shall be employed to insure that the transmitter is not modulated in excess of its modulation capability. A spurious radiation is any radition from a transmitter which is outside the frequency band of emission normal for the type of transmission employed, including any component whose frequency is an integral multiple or sub-multiple of the carrier frequency (harmonics and sub-harmonics), spurious modulation products, key clicks and other transient effects, and parasitic oscillations."

Reason: The most serious operating difficulty in amateur radio today is overmodulation by radio-telephone stations and the radiation of spurious emissions. The Commission has no rule specifically limiting the percentage of modulation of amateur stations, and it is believed that such a rule is urgently needed. The present Rule 381 is designed to prevent interference, but does not adequately express the conditions which cause interference. For convenience, the present Rule 381 reads as follows:

"The frequency of waves emitted by amateur radio stations shall be as constant and as free from harmonics as the state of the art permits. For this purpose, amateur transmitters shall employ circuits loosely coupled to the radiating system or devices that will produce equivalent effects to minimize keying impacts and harmonics. Conductive coupling of the radiating antenna, even though loose, is not permitted, but this restriction does not prohibit the use of transmission-line feeder systems."

"UNIFORM SYSTEM OF ACCOUNTS"

THE TELEPHONE DIVISION of the Federal Communications Commission announced the adoption, on June 19, 1935, of a Uniform System of Accounts for Telephone Companies to be known as "Issue of June 19, 1935, Effective January 1, 1936."

Such classification replaces the one tentatively adopted as of May 1, 1935, and to which exceptions were invited. It includes such recommended changes embraced in the exceptions as were acceptable to the Division.

The accepted changes are prevailingly technical, affecting primary accounts, rather than of a nature involving changes in fundamentals.

GOVERNMENT TELEGRAPH RATES FIXED

THE TELEGRAPH DIVISION on June 27 fixed the rates for government telegraph messages for the fiscal year beginning July 1, 1935. For the most part the existing rate of forty percent of the commercial rate was continued. For serial messages and timed wire service, however, where the commercial rate is substantially below that for full-rate telegrams, the government rate was fixed at eighty percent of the commercial rate. The minimum charges for serial messages and timed wire services were fixed at fifty-four cents and forty-five cents, respectively. Previous orders by the Postmaster General had fixed the minimum charges for day messages, day letters, night messages and night letters at approximately the commercial minimum and the Division's action carried that same principle into the more recently established serial messages and timed wire service.

The new order also provides that if any

new telegraph services are established during the fiscal year covered, the government rate will be fixed for such services at the time they are placed in operation.

The principal telegraph companies coming under the order had requested that the government rate be made the same as the commercial rate. The Telegraph Division will continue its study of the proper level for government rates with a view to determining what changes, if any, should be made at the time of issuance of the order covering the fiscal year beginning July 1, 1936.

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APPLICATIONS GRANTED FOR NEW STATIONS

Broadcast Division

May 28, 1935.

EAST TEXAS BROADCASTING CO., granted construction permit, portable-mobile, general experimental broadcast pickup, 31,100, 34,600, 37,600 and 40,600 kc, 30 watts.

NATIONAL BROADCASTING CO., Inc., Downers Grove, Illinois, granted special authorization (experimental relay broadcast station) to communicate with experimental W10XFH (stratosphere balloon) for a period of 90 days from May 20, unlimited time.

S. GEORGE WEBB, Newport, R. I., granted construction permit, 1200 kc, 100 watts, 250 watts local sunset, unlimited time.

RICHARD FIELD LEWIS, Del Monte, California, granted construction permit, 1210 kc, 100 watts, unlimited time.

June 11, 1935.

MILWAUKEE BROADCASTING CO., Milwaukee, Wisconsin, granted application, 1310 kc, 100 watts, dayfime only.

June 18, 1935.

ALEXANDRIA BROADCASTING CO., Inc., Alexandria, Louisiana, granted construction permit, 1420 kc, 100 watts, day only.

June 25, 1935.

WCBS, Inc., Springfield, Illinois, granted construction permit, portable (temporary broadcast pickup), 1622, 2060, 2150, 2790 kc, 25 watts.

Telegraph Division

May 14, 1935.

PRESS WIRELESS, Inc., Daly City, California, granted license to cover construction permit, 6440, 8350, 11,340, 16,700, 22,225 kc, 10 kw.

COPPER RIVER PACKING COMPANY, Juan, Alaska, granted construction permit, 2632 kc, 50 watts, to communicate with station WXE, Anchorage, and other point-to-point stations in the vicinity, and with ships in Alaskan waters.

May 21, 1935.

ARTHUR MEIER, Anchorage, Alaska, granted construction permit, general experimental, 31,600, 35,600, 38,600, 41,000 kc, 10 watts.

RCA MANUFACTURING CO., Inc., Camden, N. J., granted construction permit, general experimental, 1614, 2398, 3492.5, 4797.5, 6425, 8655, 12.862.5, 17.310, 23.100 kc; two transmitters of 4 and 5 kw. Also granted license covering same for period ending Oct. 1, 1936.

NORTHWEST AIRLINES, Inc., NC-303-N, granted license, special experimental, 2854, 3005, 3105 kc unlimited; 5377.5 kc day only; 50 watts. Points of communication: Primarily with aeronautical stations in the Purple Chain; and on 5263 kc on a temporary basis for the purpose of conducting test communications.

May 28, 1935.

CITY OF OCEANSIDE, California, granted construction permit (three applications) general experimental, to communicate as a municipal police station in emergency service on an experimental basis, 30,100, 33,100, 37,100 kc, 10 watts.

RICHMOND FISHERIES, Inc., Red Bluff Bay, Alaska, granted construction permit, fixed public point-to-point telephone service, 1622 kc, 50 watts.

SOUTHWESTERN HERRING, Inc., Iron Creek (Raspberry Straits), Alaska, granted construction permit, fixed public point-to-point telephone service, 2912, 2632 kc, 50 watts.

ERLE P. HALLIBURTON, Inc., NC-14242, granted aviation-aircraft license, 3105 kc, 80 watts.

CITY OF SPOKANE, Washington, granted construction permit, portable-mobile, general experimental service, to operate as municipal police station in emergency service, 30,100, 33,100, 37,100, 40,100 kc, 10 watts.

CITY OF BEVERLY HILLS, California, granted ten construction permits, portable-mobile, general experimental, 30,100, 33,100, 37,100, 40,100 kc. 4.5 watts. Also granted one similar construction permit for 50 watts and two for 1.5 watts.

CENTRAL HUDSON GAS AND ELEC. CORP., near Kingston, New York, granted construction permit, general experimental, 31,600, 35,600, 38,600, 41,000 kc, 100 watts.

CITY OF ALHAMBRA, California, granted construction permit, general experimental, 33,100 kc, 5 watts. Also authority to communicate as municipal police station in emergency service. And, same as above, three applications, portable-mobile.

CITY OF ERIE, Pennsylvania, granted construction permit, general experimental, 30,100, 33,100, 37,100, 40,100 kc, 50 watts. Also authority to communicate as municipal police station in emergency service.

TOWN OF HULL, Massachusetts, Police Headquarters, granted construction permit, general experimental, to communicate as municipal police station in emergency service on an experimental basis, 40,100 kc, 10 watts. Four similar applications also granted for mobile equipment.

CITY OF LONG BEACH, California, granted construction permit, portable-mobile general experimental, to communicate as municipal police station in emergency service on experimental basis, 30,100, 33,100, 37,100, 40,100 kc, 4.5 watts.

CITY OF ANTIOCH, California, granted construction permit, general experimental, to communicate as municipal police station in emergency service on an experimental basis, 30,100, 33,100, 37,100, 40.100 kc, 5 watts. Construction permit also granted for portable-mobile equipment.

CITY OF KANSAS CITY, Missouri, granted construction permit, portable-mobile, general experimental, 30,100, 33,100, 37,100, 40,100 kc, 7.5 watts. Also authority to communicate as municipal police station in emergency service on an experimental basis.

June 4, 1935.

PAN AMERICAN AIRWAYS, Inc., El Paso, Texas, granted construction permit, aviation-aeronautical and aeronautical point-to-point, 5405 kc day only, 2870, 3082.5, 5375, 5692.5, 8220, 12,330, 16,440 kc unlimited; 6570, 6580 kc day only: 2648, 3082.5, 5375, 8015, 16,240 kc unlimited, 200 watts.

STATE OF RHODE ISLAND, Department of Agriculture and Conservation, granted three construction permits, portable-mobile in state, 35,600, 41,000 kc, 50 watts.

AMERICAN PACIFIC WHALING CO., Akutan, Alaska, granted construction permit to install new equipment.

AMERICAN PACIFIC WHALING CO., Port Harbor, Alaska, granted construction permit for replacement transmitter and authority to operate station as a coastal harbor station.

CITY OF LYNCHBURG, Virginia, granted construction permit, police service, 2450 kc, 50 watts.

STATE OF WASHINGTON, Highway and Police Department, Ephrata, granted construction permit, police service, 2490 kc, 10 watts.

CITY OF BRUNSWICK, Georgia, granted construction permit, general experimental, police service, 30,100, 33,100, 37,100, 40,100 kc, 25 watts.

June 11, 1935.

KELLOGG AIRPORT ASSOCIATION, Battle Creek, Michigan, granted construction permit, aviation-airport, 278 kc, 15 watts.

BOROUGH OF LONGPORT, New Jersey, granted construction permit, portable-mobile, general experimental, 30,100, 33,100, 37,100, 40,100 86,000-400,000, 401,000 kc and above, 4.5 watts. Also authority to communicate as municipal police station in emergency service.

CITY OF PENSACOLA, Florida, Police Department, granted construction permit, 30,100, 33,100, 37,100, 40,100 kc, 25 watts.

CITY OF ATLANTIC CITY, New Jersey, granted construction permit (two applications) portable-mobile, 30,100, 33,100, 37,100, 40,100 kc, 9 watts.

COMMONWEALTH OF PENNSYLVANIA, Department of Forests and Waters, granted construction permits (four applications), portable, 31,600, 35,600 41,000 kc, .1 watt. Also granted license covering same. Similar construction permits, except 1 watt power, granted for Fire Tower-Lykens, Keffers Tower, Stony Mountain, Pa., and Department of Forests and Waters, Harrisburg, Pa.

W. R. E. MOORE, Kwiguk, Alaska, granted temporary authority to operate point-to-point telephone station in the fixed public service and in the public coastal service pending action on formal application; 3092.5 kc, 5167.5 kc day only, 50 watts; for period of six months.

GEORGE T. BUTLER, Hamilton, Alaska, granted six months' temporary authority to operate point-to-point telephone station in the fixed public service pending action on the formal application, 3092.5 kc, 10 watts.

GEORGE A. SHEPPARD, Chevak, Alaska, granted six months' temporary authority to operate point-to-point telephone station in the fixed public service pending action on formal application, 3092.5 kc, 10 watts.

E. B. DELL, Hooperbay, Alaska, granted six months' temporary authority to operate point-to-point telephone station in the fixed public service pending action on formal application, 3092.5 kc, 5 watts.

AERONAUTICAL RADIO, Inc., in vicinity of airports operating at Oakland and Mills Field, California, granted construction permits for two special experimental stations, portable-moble, to communicate on an experimental basis under the exceptions of Rule 320 for the purpose of determining the usefulness of ultra-high-frequencies for the control of aircraft in the vicinity of and at airports; 39,700, 39.800, 39.900 kc, 25 watts. Also granted license covering same.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

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

NAVY DAYS

C. D. GUTHRIE, a Director of our Association, submits some extremely interesting reminiscences of the early days of Radio aboard vessels of the United States Fleet.

Graduating from the Navy Electrical and "Wireless" School on June 15th, 1904, "CD" was detailed about a month later to the first-class battleship *Kentucky* as an electrician 2nd class, for duty in the dynamo room. There was no radio shack on board at the time, but one was in the process of construction at the Navy Yard.

In September, 1904, a Slaby Arco 1¼ kw mercury turbine interrupter transmitter and a coherer receiver, complete with a Morse Writer, were installed on the *Kentucky,* which equipment was in that day the last word in radio installations. Early in 1905 "CD" was transferred to the radio room from the dynamo room.

The International Morse Code was taught in the Navy Electrical School, but the Meyers Code (also called the Navy Code and the Wigwag Code) became standard for Fleet Use. The idea was to use signalmen from the bridge, if necessary, for radio work, but this did not work out so well. About March, 1905, Admiral Barker lowered his flag from the *Kearsarge* and Admiral Robley D. Evans hoisted his flag on the new *Maine* as Commander-in-Chief. The Navy Code immediately became a thing of the past. The new flagship inaugurated the use of the Continental Code as the official code. Later the American Morse Code became the unofficial code and remained such until midnight, December 31st, 1907, when its use became a Court Martial offense. "CD" had just taken charge of the radio station at the Philadelphia Navy Yard when the General Order prohibiting the use of American Morse was received.

The radio station on the *Kentucky* was placed in charge of a third class man after the chief was discharged; a rather unusual procedure, but due, probably, to the fact that he was a second cruise man. This state of affairs continued for about four months and all experiments had to be carried on when this man was ashore as it was his contention that Navy Regulations prohibited changing the equipment. Later the "Third Class Chief" as he was called, had his request for a transfer to the West Coast approved. No sooner had the Chief left en route to his new assignment than experiments began in the radio room. An electrolytic detector made by filing the tip off a five-candle-power lamp and placing a few drops of dilute sulphuric acid inside, was immediately placed in service. This detector, used with a pair of low-resistance head phones, made the receiver far more sensitive than the coherer arrangement. Up to that time the maximum distance obtained using the coherer was approximately 150 miles, and this was considered good work.

The Mercury turbine interrupter next received attention. From a two-segment affair, giving about a 25-cycle note (very difficult to copy through static) the mercury interrupter was changed to a four-segment interrupter, changing the note to something like a 240-cycle note. Four segments then grew to six and a note close to 500 cycles in pitch was obtained. Many requests were received from operators on other vessels for the *Kentucky* operators to lower the tone as it was said to be irritating to the nerves. This was accomplished simply by reducing the speed of the motor.

During the period of these early experiments Naval Radio Stations were located very close to one another and for the most part were powered with mercury interrupter equipment.

Late in the fall of 1905 a complete Shoemaker radio receiver was installed, using a single coil with two sliders and an electrolytic detector consisting of a zinc rod amalgamated with mercury and a platinum wire embedded in glass with the electrolyte a 20% sulphuric acid solution. This receiver was equipped with an antenna switch, a device not incorporated in previous makeshift receivers of the same type. It was not an uncommon occurrence to be thrown from one's chair when making the first dot, due to improper switching.

The Shoemaker receiver was, in general, a very good one except that the "glass" point allowed a tiny bubble of hydrogen to remain on the bottom, resulting in the weakening of signals and in some cases causing them to fade out completely. To overcome this the operator had to wriggle the hard rubber cup with one hand and copy with the other. The Stone Radio Company about this time placed on the market an "electrolytic" having a glass point with the bottom bent at an angle of 90 degrees, and this proved most satisfactory, as the bubbles raised to the surface.

Early in January, 1906, when the Atlantic Fleet was leaving New York for Culebra, the *Kearsarge* and the *Kentucky* ran ashore off Sandy Hook, and the *Alabama* in coming alongside gave the *Kentucky* a nasty side swipe. This caused the *Kentucky's* return to the Navy Yard for two weeks at dry dock. The rest of the fleet proceeded to Culebra. On the voyage south, when the *Kentucky* was about 800 miles from this island, the flagship *Maine* was heard working. The *Maine* was called and immediately replied. The Captain was astonished when informed of this contact and he dispatched a lengthy "OFM" (official message) which was transmitted without difficulty to the *Maine*. Newspapers of that day carried items captioned "Wonderful Feat by U. S. Warship."

During this period radiomen on other ships were experimenting in attempts to increase communication range. The new *Maine* was the only ship that offered the *Kentucky* keen competition until the *Connecticut* and her sisterships joined the fleet, equipped with 3 kw spark sets and "ultra-modern" receivers. The *Kentucky* subsequently dropped from second ship in the Fleet to sixteenth place.

(Sec'y Note: "Jerry" Guthrie promises us more interesting items concerning early Navy Radio Days for use in future issues. Many thanks, Jerry, and we trust that others will likewise contribute interesting experiences for use in this page.)

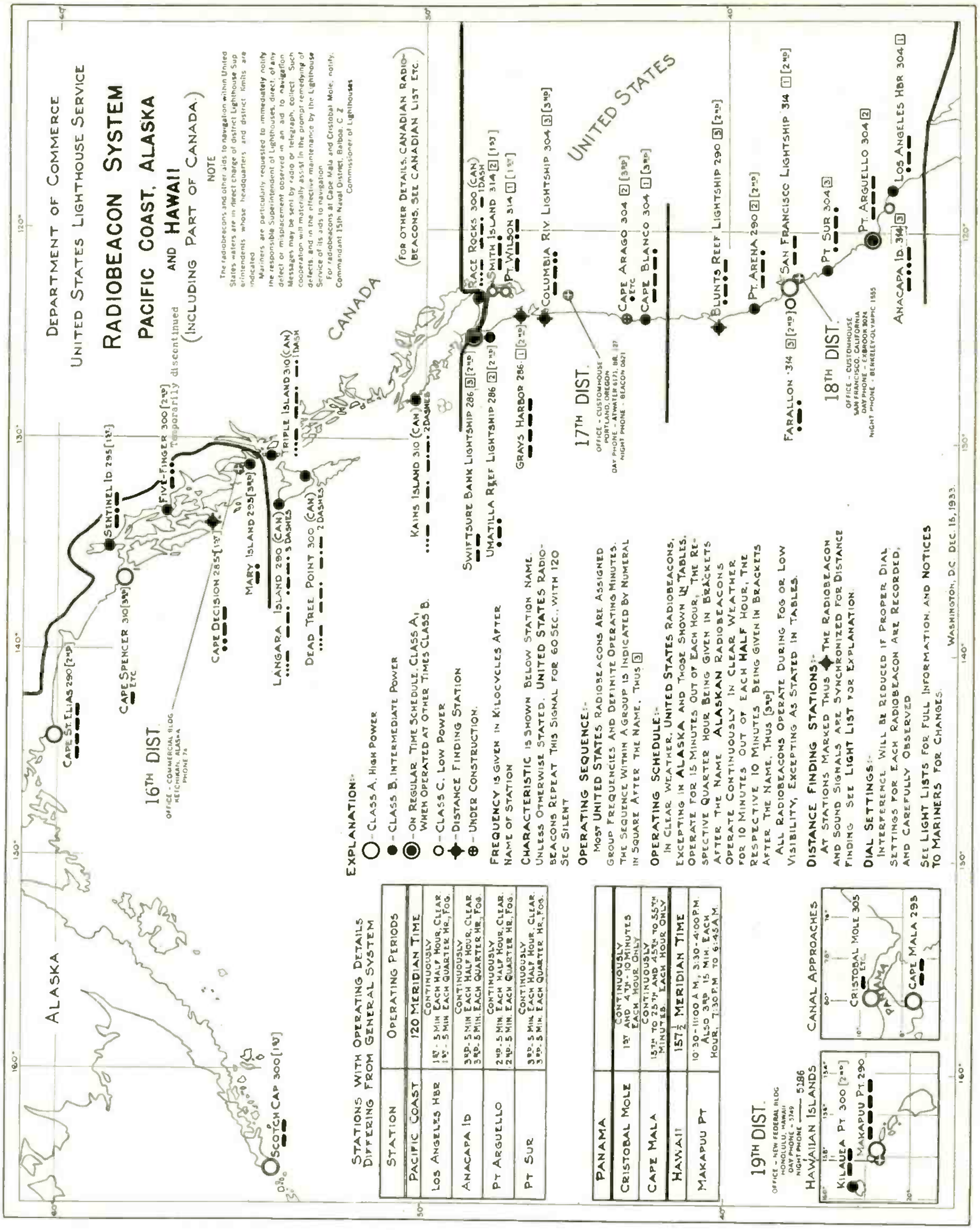
TELL US——

When you change your mailing address. When you change your business connection. That you wish to remain in good standing but must delay payment of current dues. Though you paid your dues, you did not receive your membership card. (Such things do happen.) What kind of material you would like to see in this page. Of your radio experiences back in the "dark ages," or of present-day radio communication feats. Of accomplishments of fellow members too modest to make known their prowess.

Your comments and suggestions will be greatly appreciated. Cooperation along these lines will immeasurably simplify the handling of Association activities.

PERSONALS

We were pleased to see Matt Bergin at the last meeting. MB came up from the RCA Radiotron plant, at Camden, N. J., to personally receive a Testimonial awarded him by the Association recently for his excellent radio work aboard several ships in disaster. Come soon again, MB, and bring along a delegation of our members from the Camden plant. Always a hearty welcome awaiting you. . . . Ye Sec'y attended the Hudson Division American Radio Relay League Convention at the New Yorker and it seems everywhere he turned a VWOArian was sure to be. Henry T. Hayden was there in charge of the Ward Leonard booth. HTH is one of the most active supporters. He had two prospective VWOA members under his wing that night and has since sent in several names of likely applicants. J. C. Muller, Fred's brother, was there with Mrs. Muller and a group of friends. . . . Arthur H. Lynch was there, too, lecturing on his latest developments in vertical antennae and taking part in the festivities of the evening. . . . Congratulations are due Kenneth Hill, the Hudson Division Director, for the really stupendous turnout of amateurs representing twenty-two states, and a total attendance of well over 600 persons and an appreciable overflow which could not be taken care of in the Main Ballroom. . . . Carl O. Petersen tells us upon his recent return with the Byrd Expedition from the South Pole that while down south he participated in 21 flights totaling 70 hours. He says that while he is glad to be back to civilization, his sojourn in the Antarctic was a pleasant one. Hope to see you around often, COP, now that you will be in New York for a spell. . . . An interesting letter from Joseph F. Welsh from Wood-Ridge, N. J. . . . Request for an application from L W. Briggs, Utica, N. Y. . . . An application from Arthur Enderlin, for the past seven years with Mackay Radio in Honolulu. . . . Our former Treasurer, V. H. C. Eberlin, requests many application blanks and other literature so that the Miami chapter of the VWOA may become a reality. We'll have to shake off the *manana* spirit induced by a current torrid period and comply with this and other similar requests. . . . 73 'til this time next month.



MAP No. 8 - - 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 DECEMBER 15, 1933.

OVER THE TAPE...

BURGESS TRI-SIX TELEPHONE BATTERY

The Burgess Battery Company announces another new telephone battery, the Tri-Six, a 4½-volt battery engineered especially for telephone service. The Tri-Six is a further development of the Burgess Twin-Six. The latter, a 3-volt battery, was designed to replace two No. 6's. The Tri-Six will replace three No. 6's. It is especially suited for Western Electric and other types of telephones which normally use three No. 6's.

The new Tri-Six is 5-5/16" high x 3-15/16" wide x 3-13/16" deep—40% smaller than 3 No. 6's. Has waterproof, leakproof, heat-welded jacket which resists moisture, oils, and battery liquids. Its square shape makes it much easier to handle than three No. 6 cells. When installing the Tri-Six, you have only two connections to make instead of six.

The Tri-Six contains 12 cells made of heavy drawn zinc cans and protected by "Chrome," a preservative which retains power when the battery is not in use. The 12 cells are connected in series-parallel to give 4½-volts.

It is purposely made of low-amperage cells to give a longer life in service than can be obtained from three No. 6 batteries. It has 12% more active zinc surface than three No. 6 cells.

The Burgess Tri-Six will be distributed by the Inland Equipment Company, Indianapolis, Indiana, which also distributes the Twin-Six.

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NEW UNIVERSAL RECORDING MACHINE

A new professional recording machine was put on the market in May by the Universal Microphone Co., Inglewood, Cal. The assembly is completely mounted on cast iron castings and weighs 125 pounds with a turntable disc of 16 inches.

A rim drive feature, which "steadies" recording, distinguishes the model from earlier non-professional types of machines. The motor is a constant-speed type, not self-starting, 110-volt a-c. is 100% synchronous and is reversible.

One outstanding feature is the countershaft which makes it possible to use 78 or 33⅓ rpm, and on 50 or 60 cycles a-c. Although the machine is set for 108 lines per inch, standard, it can be changed to any number of lines desired.

The cutter is a special Universal power cutter with four pole pieces and screw adjustments for damping. The magnet is of cobalt steel. The cutter arm is of heavy bronze casting. For grooving aluminum an adjustment screw in soft rubber cushion is provided to maintain a constant pressure on the point of stylus, thus controlling groove depth. For cutting cellulose, acetate or nitrate discs a different situation exists and the professional recorder comes equipped with minute adjustments for different types.

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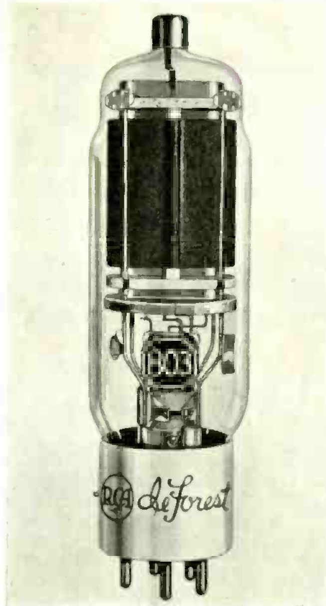
RCA 803 R-F POWER AMPLIFIER PENTODE



The RCA 803 is a pentode transmitting tube of the filament type for use as an r-f amplifier, frequency multiplier, oscillator, and suppressor- or grid-modulated amplifier. The plate connection is brought out through a separate seal at the top of the bulb to insure high insulation and low interelectrode capacitances. In adequately-shielded circuits, neutralization to prevent feedback and self-oscillation is generally unnecessary. The suppressor is connected to its individual base pin. The maximum rated plate dissipation of the 803 is 125 watts.

Following are the tentative characteristics of the 803, together with maximum ratings and typical operating conditions for one class of service:

Filament Voltage (a-c or d-c)	10 volts
Filament Current	3.25 amperes
Mutual Conductance (I_p: 55 ma)	4000 micromhos
Direct Interelectrode Capacities:	
Grid—Plate (with external shield)	0.15 max. mmfd.
Input	15.5 mmfd.
Output	28.5 mmfd.

As r-f Amplifier—Class B Telephony

(Carrier conditions per tube; for use with a modulation factor up to 1.0)

Plate Voltage	2000 max. volts
Screen Voltage (Grid No. 2)	600 max. volts
Suppressor Voltage (Grid No. 3)	60 max. volts
Plate Current	90 max. ma.
Plate Input	180 max. watts
Plate Dissipation	125 max. watts
Screen Dissipation	20 max. watts

TYPICAL OPERATION:

Filament Voltage (a-c)	10	10	10	volts
Plate Voltage	1250	1500	2000	volts
Screen Voltage	600	600	600	volts
Suppressor Voltage	40	40	40	volts
Grid No. 1 Voltage	—40	—40	—40	volts
Peak r-f Grid voltage (Approx.)	55	55	55	volts
Plate Current	80	80	80	ma.
Screen Current	15	15	15	ma.
Grid Current	3	3	3	ma.
Driving Power (Approx.)*	1.5	1.5	1.5	watts
Carrier Power Output (Approx.)	33	40	53	watts

*At crest of a-f cycle.

Because of its high power sensitivity, the 803 should prove particularly advantageous for use in conjunction with small, light-weight portable and mobile transmitters for phone and/or cw use.

PRECISION RESISTORS

A series of wire-wound resistors, known as Microhm, constructed in various forms to satisfy both production and laboratory requirements, is offered by the Precision Resistor Co., 334 Badger Avenue, Newark, N. J. These resistors may be obtained in ratings from ¼ to 5 watts in non-inductive type units, and other types up to 40 watts. The units are suited to use in meter shunts and multiplier resistors. A circular describing the units may be obtained from the manufacturer.

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IMPROVED DYNAMIC MIKE

The Radio Receptor Co., Inc., 106 Seventh Avenue, New York, N. Y., have announced that their Model 6-C moving-coil microphone has been improved to such a degree that it possesses practically the same sensitivity as the better-type carbon mikes. The improvement has been accomplished through the use of a specially designed input transformer. This development is said to make it possible to replace carbon microphones with the dynamic type whenever desired.

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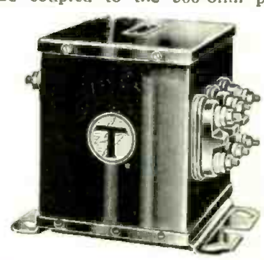
VARIABLE IMPEDANCE MODULATION TRANSFORMER

The Thordarson Electric Manufacturing Company, 500 West Huron Street, Chicago, Illinois, announces a new transformer for use in radio transmitters which permits coupling the 500-ohm output of any audio amplifier to any r-f plate circuit carrying not over 215 milliamperes of direct current. It will handle up to 80 watts of audio power.

The primary of this transformer is wound to match the impedance of a 500-ohm line. The secondary is tapped to match a 5000, 6000, 7000, 8000, 9000, or 10,000-ohm plate circuit impedance.

This transformer may be permanently connected to the plate circuit of the r-f amplifier tube in a transmitter and any standard public-address amplifier system may be coupled to the 500-ohm primary



whenever it is desired to modulate the signal from an audio circuit.

This is said to be the first time the universal system of coupling, popularized in small radio output transformers, has been applied to a large unit employed in transmitter circuits.

The size of this new transformer, known as T-7532, is 6½" x 5¾" x 8". The weight is 16½ lbs. Its audio characteristic is essentially flat up to 7000 cycles.

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HIGH-PERMEABILITY TRANSFORMER CASTINGS

The Alloy Transformer Company, 135 Liberty Street, New York City, are now producing a new line of high-permeability, hum-proof transformer castings. These units are obtainable in all sizes.

All types of audio, power and transmitting transformers will be built to order.

Literature may be obtained on request.

"The Market Place"

Manufacturers are requested to send data on their new products for use in the communications and broadcasting field, promptly, for inclusion in "The Market Place" section.

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