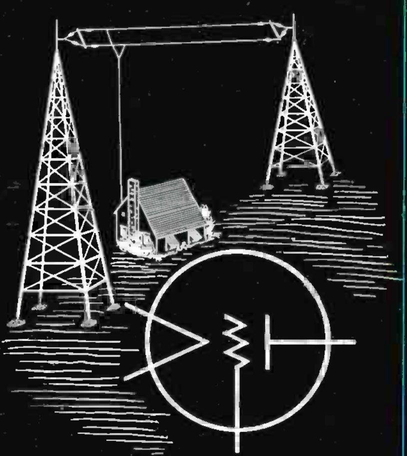
JANUARY, 1934

Radio Engineering



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VOL. XIV NO. 1

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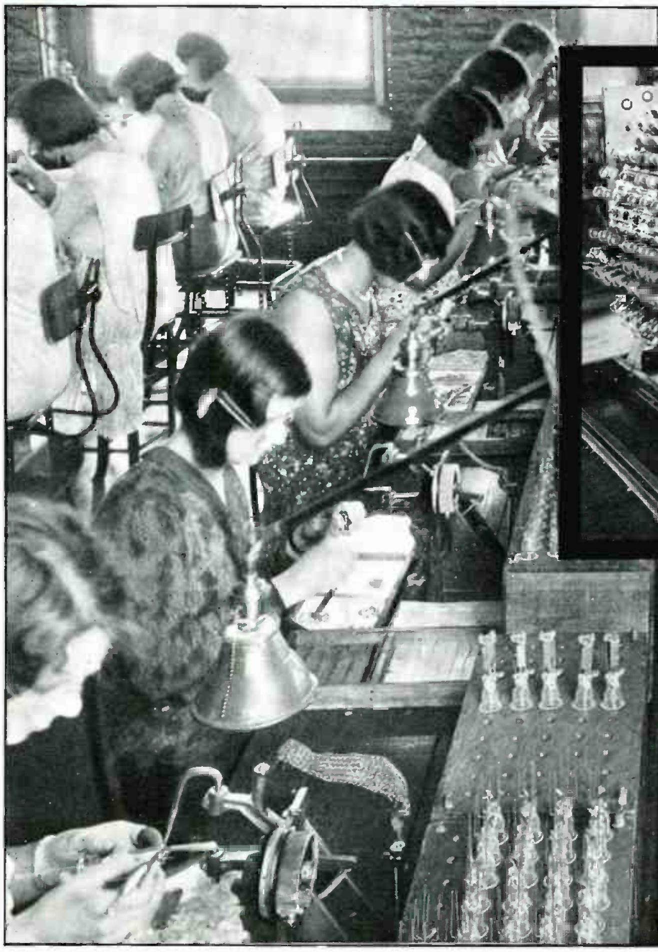

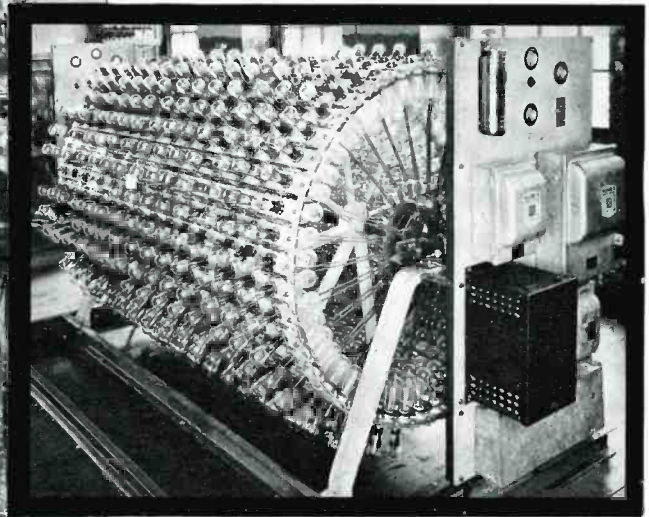

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RADIO ENGINEERING

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MEMBER AUDIT BUREAU OF CIRCULATIONS

Editor
DONALD MCNICOL

Managing Editor
F. WALEN

Vol. XIV — JANUARY, 1934 — Number 1

Contents

Departments

WBBM AND KFAB SYNCHRONIZE

TWO installations of synchronizing equipment have been ordered and are ready for shipment to WBBM, Chicago, key station of the Columbia Broadcasting System, and to KFAB, Lincoln, Nebraska. These two stations contemplate synchronizing the latter part of this month (January).

This marks the first move to be made towards synchronized broadcasting on a common frequency by any stations in the United States since the North American Radio Conference in Mexico. The move is regarded as significant inasmuch as it may signalize the widespread introduction of synchronization in the commercial broadcasting industry of the country.

The perfection of synchronizing equipment now makes such a development a practical possibility. The equipment to be used by WBBM and KFAB provides a precision of carrier frequency never before approached in broadcasting transmitters. It has been developed by Bell Telephone Laboratories as a result of years of experimentation which as early as 1927 produced successful tests with synchronous operation.

BRYAN S. DAVIS
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JAS. A. WALKER
Secretary

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Editorial

JANUARY, 1934

THE BROADCAST VERTICAL ANTENNA

DETACHING the subject of vertical antennas in particular from the general subject of antennas, the history of development is fairly clear. Notwithstanding that there was a somewhat disconnected prior literature of the subject, disclosing investigations and deductions made by M. Abraham, G. W. Pierce and others, it is probably true that Stuart Ballantine's papers of 1923 and 1924 made up the earliest useful consolidation of knowledge on the subject. From Cambridge on November 8, 1923, came a highly important paper by Ballantine entitled: "On the Radiation Resistance of a Simple Vertical Antenna at Wave Lengths Below the Fundamental." Also, a paper entitled: "On the Optimum Transmitting Wave Lengths for a Vertical Antenna Over Perfect Earth."

In the first mentioned paper there was presented an original method of computation making use of sine and co-sine integrals. The second paper considered the idealized problem of transmission from a perfect vertical antenna over perfectly conducting plane earth. The amount of energy radiated in various altitudinal directions was calculated and distribution diagrams were presented illustrating special cases.

These papers were recognized as masterly presentations, even if in some particulars speculative.

It is a tribute to Mr. Ballantine's grasp, ten years ago, of what was an involved subject, that later experience with antennas by engineers identified with the design and construction of broadcast antennas confirmed his mathematical conclusions. Out of these determinations grew the useful general theorem that as the height of the antenna increases above a quarter wavelength there is a decided gain in the low angle on ground waves at the expense of the so-called sky waves. This has recently been put to extensive practical use in the construction of vertical antennas for broadcast transmission, with considerable increase in economy over conventional structures and methods of operation.

RADIO LOOKING FORWARD

WHEN it is said that the curve of radio development has flattened it is probably meant that the department of radio represented by the home broadcast receiver has produced an instrumentality for instruction and entertainment which is good enough from the viewpoint of the average purchaser.

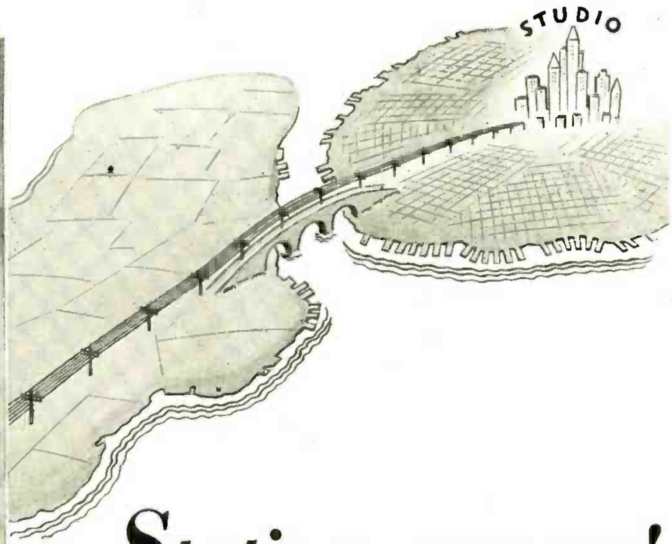
The radio receiver of today, serving as one-half of the system the other half of which is highly developed broadcasting, is the result of the work of a host of engineers and technicians.

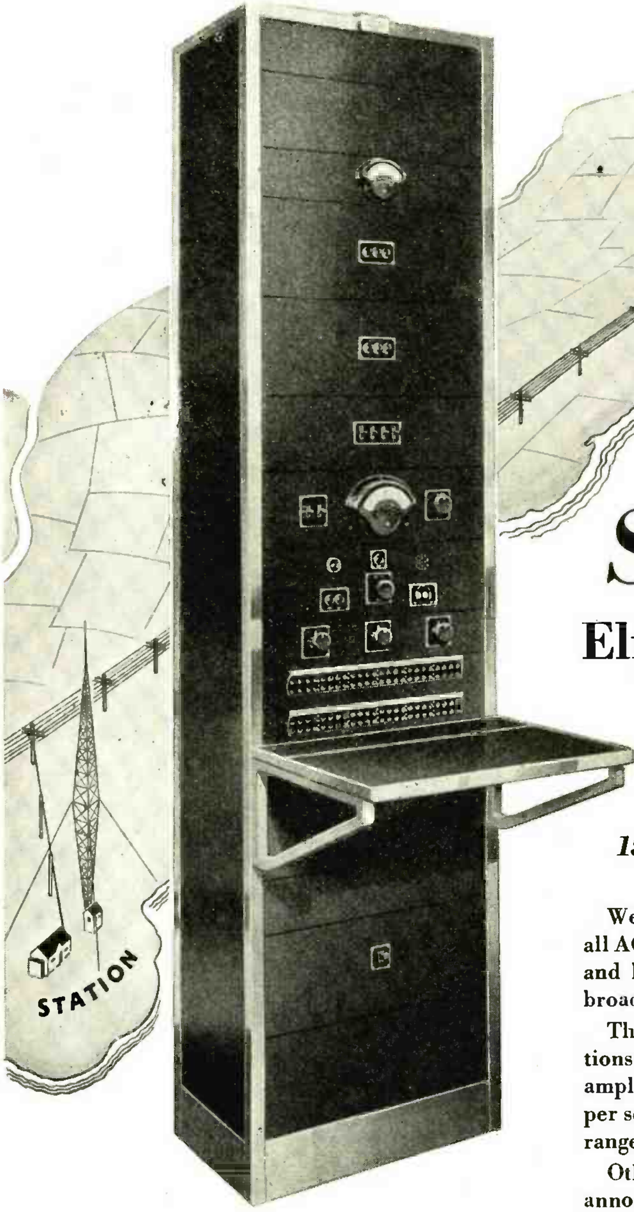
No one else knows as the engineer knows that there will be betterments. No one else knows as the engineer knows that as transmission and reception are improved still further the term "good enough," although it may then signify a more critical standard of measurement, is likely to continue as a determining factor in the reasoning of the purchaser.

It is in the record of the engineer's achievements that we find the evidence of his power and the credentials of his labor. Into the results of work each generation pours its life. As the results grow in excellence, with finer products, richer tones and tints, and nobler meanings, they become the mile-posts of an industry's progress.

The keynote of life is progress. Each successive generation contributes something —a compass, a windmill, a water pump, a printing press, the telegraph, the telephone, electric light, radio. These results of work have been added to the general stock. These accumulated facilities and conveniences are here to serve our needs. May they serve also as inspiration to us to see to it that our generation's contribution to progress is not lacking in quality nor in quantity.

Donald McNicol
Editor





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Western Electric's new 15A Speech Input Equipment—all AC operated from commercial power mains—is designed and built by radio engineers with practical knowledge of broadcasting station technique.

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Other features: Moving Coil Microphone for emergency announcing; 4 incoming program circuits, 2 telephone order wire circuits, 2 outgoing program circuits; improved volume indicator with highly damped meter which follows envelope of program impulses.

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RADIO ENGINEERING

FOR JANUARY, 1934

Of interest to all in the industry

NEW WIRELESS COMMUNICATION BETWEEN FRANCE AND ENGLAND

ACCORDING to recent reports, the British Air Ministry has announced that there will be put into operation, in the near future, a radio telegraph system utilizing ultra-short waves of 15 to 17 centimeters, between the British Lympne aerodrome and the French aerodrome at St. Inglevert. It is stated that this new system will offer certain advantages over ordinary wireless and cable transmissions employed up until now in that communications made will be exempt from all interference.

◆

TELEVISION FROM MOVIE SCREENS

WHILE television broadcasts to date have been built around programs given by "live" casts, experiments have been made which show that motion pictures can not only be satisfactorily televised, but have definite points of superiority. One of these is that the motion picture screen, as a flat surface, makes it easier for pictures to be picked up by television transmitters than would be possible if several characters were moving about a stage.

◆

RMA REPRESENTED ON INDUSTRY COMMITTEE

PRESIDENT ROBERT LUND of the National Association of Manufacturers has invited Bond Geddes, executive vice-president-general manager of the RMA to be represented on the committee of fifteen trade association representatives to organize a special section of national industry to deal with larger industrial problems developed under the NIRA, AAA and other legislation.

◆

100 KC. TO SPARE

ADDITIONAL RMA recommendations to the Radio Commission regarding the use of frequencies between 1500-1600 kilocycles, recently opened to use by the Mexico City International Conference, are under consideration. There has been much adverse comment against such extension of the broadcast band for a mere increase in the number of broadcasting stations, and engineering opinion also favors channel separation of 20 kilocycles in this part of the spectrum.

In the broadcast band 1500-1600 kc., the Radio Commission on December 19 allocated three frequencies for "experimental" broadcast stations to be separated by twenty kilocycles as recommended by the RMA. The frequencies assigned are 1530, 1550 and 1570 kc. with limits of one kilowatt power, with permission to carry sponsored programs and for which several applications already have been filed.

The allocation by the Commission followed recommendations of Dr. C. B. Jolliffe, chief engineer, and George B. Porter, acting general counsel.

◆

TELEVISION RECOMMENDATIONS MADE TO RADIO COMMISSION

RECOMMENDATIONS regarding broadcast allocations for television have been made to the Federal Radio Commission by the RMA. Following approval by the RMA Television Committee, of which D. E. Replogle is chairman, and also of a special RMA committee headed by Walter E. Holland, the Association has formally requested the Radio Commission to reserve for television service a continuous band of frequencies from 40 megacycles to at least the neighborhood of 110 megacycles. The RMA resolution also declared that from present indications the television requirements of the future will be such that assignments in the television band should be at least four megacycles wide, to provide continuously entertainment and television service.

◆

SAYS DUN-BRADSTREET

WHILE the radio industry suffered acutely from the weight of economic adversities during the last three years, it is emerging triumphant from the most severe period of business recession through which the world ever has passed, with a convincing demonstration of the indispensable usefulness and need of its products.

VISUALIZING THE FORMULA

By Carlton A. Mizen

IN radio engineering, as in every other form of engineering, mathematical computation depends upon the simple fact that there exists a functional relationship between the observed members of the computation. The reactance of a condenser, for instance, depends upon the frequency at which the reactance is measured; therefore, we say that capacity reactance is a *function* of the frequency. Similarly, we can show that the power factor is a *function* of the phase angle, or that the resistance of a given length of wire is a *function* of its cross sectional area.

We are all familiar with at least three methods of representing a function. The simplest, perhaps, is the tabulation method, wherein we write in the first column the successive values of a given independent variable, then write in the second column the corresponding value of the function of the independent variable. Another way to represent a function is by the graphical method, which is simply to plot the observed points on a piece of squared paper, and to connect the points with a smooth curve. We are thus able to tell at a glance, for example, the general frequency characteristics of a certain type of amplifier, or the rise and fall of business volume over a period of five years. Finally, the most concise method of representing a function is the analytic, or formula method. The engineer's handbook is full of such representation, the expression $Z = R + jX$ being a familiar example.

Of the three methods, the graphical method is the only one through which the nature of the function may be truly visualized. The analytic method is the only one where for any given value of the independent variable the value of the function may be computed with a high degree of accuracy. Now, whereas the engineer habitually concedes that the graphical method of representing a series of observations is more valuable to him than the tabular representation, he does not customarily use the graphic method in preference to the analytic method. There is something so concise and final about the formula in the handbook that he prefers to use it without modification. It is the purpose of this account to represent some well-known formulas in a graphical manner, and to show how certain routine computations may be made in one tenth of the usual time. To promote a better understanding of the actual time-saving graphs, certain obvious developments must be presented first, and the reader will doubtless profit by a careful consideration of the simple graphs shown in Fig. 1.

If one were to make a frequency-reactance curve of a 1 microfarad condenser, the graph would take the form shown in Fig. 1 (a). The general analytic representation of the capacity reactance for any specified frequency is given in handbooks:

Capacity reactance, $X_C = \dfrac{1}{2\pi f C}$; which equation may also be expressed $fX_C = \dfrac{1}{2\pi C}$.[1]

Fig. 1(c) shows a family of straight lines formed by making the frequency-reactance curves of several dif-

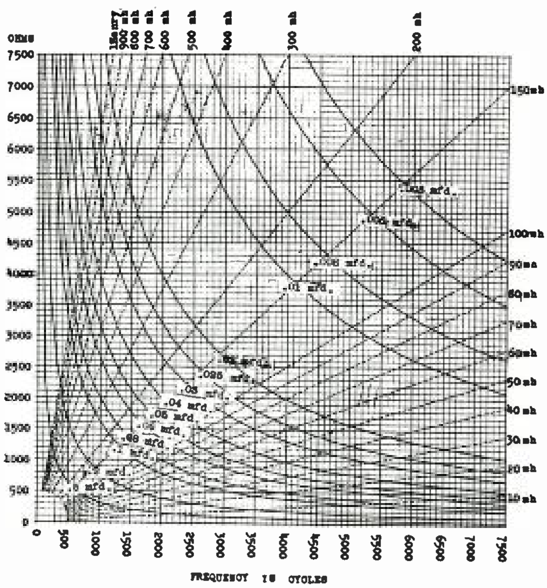

Fig. 2.

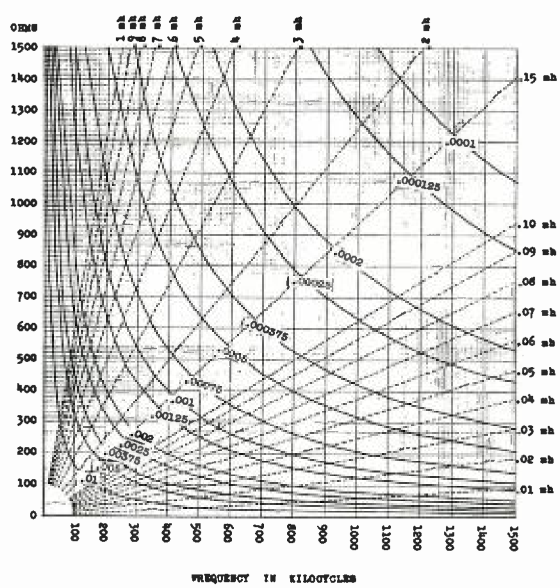

Fig. 3.

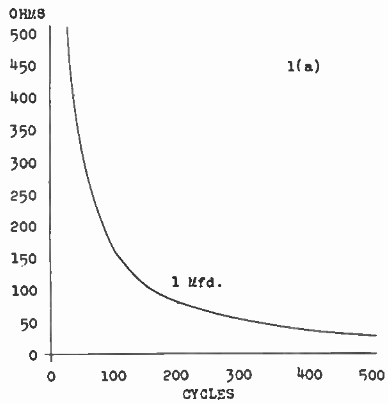

Fig. 1 (a).

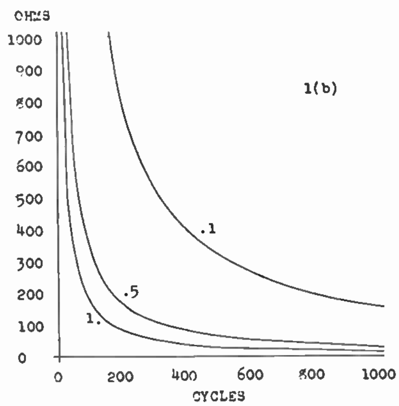

Fig. 1 (b).

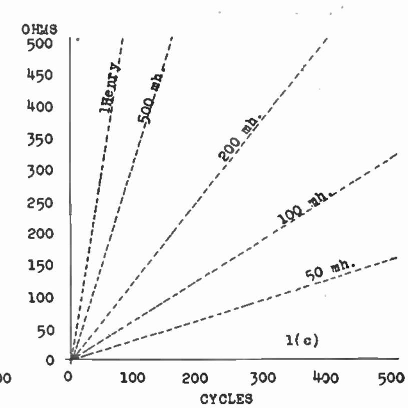

Fig. 1 (c).

ferent inductances. The handbook formula for the value of inductance reactance at any specified frequency is: $X_L = 2\pi fL$ where L is the inductance in henrys.[2]

If we study Fig. 2 carefully, the usefulness of a composite type of graph must become evident. Fig. 2 represents the frequency curves of several standard sizes of inductance reactances and capacity reactances used in audio-frequency work. If we wish to know, for example, the reactance of 300 mh. inductance at 2000 cycles, we follow the vertical 2000 cycle line to the point where it crosses the 300 millihenry line. Notice that this crossing point is on the horizontal level of 3770 ohms. This simply means that the reactance of 300 mh. is 3770 ohms at 2000 cycles. Similarly, we could show, for instance, that the capacity reactance of a .04 microfarad condenser at 1500 cycles is 2652 ohms. Operations so far have been the obvious ones for which the separate graphs were designed.

If we assume that the inductance, 100 millihenrys, is in series with the capacitance, .1 microfarad, and we wish to find their frequency of resonance, we may reason that at the frequency of resonance the magnitude of the capacity and inductance reactances will be equal (though their sign is opposite), and we can expect an intersection of the capacity and inductance reactance curves at this point. In Fig. 2 we find the intersection of these curves (100 mh. and .1 mfd.) at a frequency level of 1590 cycles. In other words, 1590 cycles is the resonance frequency of this particular series combination. Of course the total series reactance (measured on the reactance scale) will be 1000 ohms (inductance reactance) minus 1000 ohms (capacity reactance), or zero.

What will be the total reactance of this combination at some other frequency, say 3000 cycles? We follow the 3000 cycle line to the point of its crossing the .1 mfd. line, note that the reactance level is 530 ohms, then continue along the 3000 cycle line to the point where it crosses the 100 mh. line at the reactance level of 1885 ohms. The total reactance of the series combination at 3000 cycles is 1885 minus 530 ohms or 1355 ohms, and is positive because the inductance reactance was predominant (being 1885 while the capacity reactance was only 530).

In Fig. 1(d) are shown several useful networks of the filter and bridge type. The impedance Z facing into these networks is found to be a constant, pure resistance, independent of frequency, provided that the following relations exist: $R = Z = \sqrt{L/C}$.

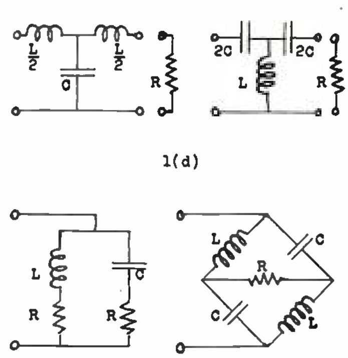

Fig. 1 (d).

Now, the important term L/C may be found immediately from composite graphs (Figs. 2 and 3), if we note the reactance level at which the L and C lines cross. Where L is 300 mh. and C is .04 mfd., for instance, their reactance curves cross at 2740 ohms reactance level. The absolute number 2740 is equal to $\sqrt{L/C}$ where L is expressed in henrys (in this case .3 henry) and C is expressed in farads (here .00000004 farad). If the bridge circuit employed the values 300 mh. and .04 mfd. in the indicated places, then each value of R must be 2740 ohms for the impedance Z to be a constant, pure resistance of 2740 ohms. These reactance-resistance circuits are employed where it is necessary to have a constant impedance, and yet have a variable propagation characteristic.

The expression $\sqrt{L/C}$ has another important use in measuring the total reactance of a circuit where the inductance and capacity are placed in parallel instead of in series. We have already seen how to find the combined series reactance by use of the graph. If we call the series reactance X_s, then the reactance of the same frequency will be:

$$\text{Parallel Reactance} = \frac{\frac{L}{C}}{X_s} = \frac{(\sqrt{L/C})^2}{X_s}.$$

By way of summary and review, let us solve some simple problems by the use of the graph in Fig. 2.

Given a 300 mh. inductance in series with a .02 mfd. condenser:

(a) Find the resonance frequency.

(b) Find the value of the quantity $\sqrt{L/C}$.

(c) Find the total reactance at 3000 cycles.

(d) If the units had been in parallel, what would have been the total reactance at 3000 cycles?

Answers:

(a) The 300 mh. line crosses the .02 mfd. line at a frequency level of 2054 cycles. This is the resonance frequency.

(b) The reactance level at which this resonance crossing occurs is 3870 ohms. The numerical value of $\sqrt{L/C}$ is therefore 3,870.

(c) If we follow the 3000 cycle line we find that it crosses the .02 mfd. line at 2650 ohms; following the 3000 cycle line upward from this point, we find it crossing the 300 mh. line at 5656 ohms. Total reactance is 5656 minus 2650 or 3006 ohms, which is positive because inductance predominates.

(d) In (b) we found the value of $\sqrt{L/C}$ to be 3,870; from (c) we find the total series reactance to be 3006 ohms. By formula, the parallel reactance

$$= \frac{(\sqrt{L/C})^2}{X_s} = \frac{(3870)^2}{3006} = 4982 \text{ ohms.}$$

Incidentally, capacity is predominant in this case, the predominance for a parallel connection always being opposite that of a series connection of the same units.

From a graph like Fig. 2, one may solve quickly the following formulas (assuming standard sizes of condensers and inductances):

(a) $X_L = 2\pi f L$

(b) $X_C = \frac{1}{2\pi f C}$

(c) Resonance Frequency $= \frac{1}{2\pi\sqrt{LC}}$

(d) Series Reactance $= (2\pi f L - \frac{1}{2\pi f C})$

(e) $y = \sqrt{L/C}$

(f) Parallel Reactance $= \frac{2\pi f L}{(1 - 4\pi^2 f^2 LC)}$

(g) The derivative with respect to frequency of the capacity reactance function, thus:

$$\frac{d}{df}\frac{1}{2\pi f C} \text{ at any specified frequency.}$$[3]

[1]*In the latter form, for any given capacity value C, the right-hand expression* $\frac{1}{2\pi C}$ *is a constant, and the equation evidently falls into the class* $xy = k$*, which is the equation of a rectangular hyperbola. Fig. 1 (b) shows the frequency-reactance curves of three different capacity values, each curve being obviously a section of a rectangular hyperbola.*

[2]*For a given value of L, this equation evidently falls in the general class* $y = mx$*, which is the equation for a family of straight lines radiating from the point (0, 0). The angle which each line makes with the horizontal base line is anti-tangent* $2\pi L$.

[3]*The slope of the capacity reactance curve at its point of intersection with any inductance reactance line is seen from the graph always to be the negative slope of the inductance line. In other words, the derivative of the capacity reactance function at that point is* $-2\pi L$ *(assuming the x and y scales to be equal). A method for finding the derivative of the capacity reactance function at any point whatever is to divide the reactance at that point by the frequency, and to affix the negative sign. Our justification for doing this is quite apparent if we return to the analytic expression:*

$$\frac{d}{df}\frac{1}{2\pi f C} = -\frac{1}{2\pi f^2 C} = -\frac{\frac{1}{2\pi f C}}{f}$$

◆

WIRED RADIO REQUIRES LICENSE

THE FEDERAL RADIO COMMISSION, in conjunction with the Department of Justice, recently was successful in prosecuting the case of the U. S. v. Norman Cohen, who was indicted for operating a radio station without a station license at Bridgeport, Conn.

The defendant contended that he was operating his station by wired radio and therefore no license was required from the Federal Radio Commission. He further contended that the signals from his transmitting equipment were emitted through the power lines in the city of Bridgeport; from there were received at receiving stations that were connected with these power lines, and, therefore, the system was not a radio station as defined in the radio act.

The Government contended that this transmitting equipment acted as a radio station and emitted signals through the air as any other station, which signals were picked up by receiving sets connected with ordinary antennas. To prove this point, the commission presented evidence showing that the station was heard in the state of Connecticut by regular receiving sets with antennas attached, and when the antennas were disconnected no signals were received from the station. In addition to this, the Government showed by agents of the Federal Radio Commission, that the signals were received in the state of New York upon an isolated receiving set not connected with power wires used by the transmitting station, thereby proving that no connection was necessary with the wire lines as contended by the defendant.

The commission contended and proved by experts that the system used by Cohen was not really a wired radio system but an ordinary radio station.

The jury rendered the verdict of guilty on two counts, the first being the operation of the station without an operator's license, and the second the operation of the station without a station license. Judge Fincks, who heard the case, fined the defendant $25 after a plea of leniency by his counsel.

This case is the first one coming up in which the question of wired radio has been involved, and has a very important bearing upon further operation of stations of this kind.

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MEMBERSHIP IN THE IRE

SUBBSCRIBERS to RADIO ENGINEERING, not already members of the Institute of Radio Engineers, may procure application forms by writing for same to the editor of RADIO ENGINEERING.

CHECKING UP ON 1933

IN the family of industries radio stood out as a comparatively up-and-coming member in the year just closed. This, notwithstanding that radio manufacturers did not get rich on net receipts, and that many radio engineers were unemployed or were on part time.

The advances for the year were mainly of a technical nature which will contribute substantially toward industry growth in 1934 and the years ahead.

A widely recognized forward step was the construction of the center in New York known as Radio City. NBC's new radio studios housed in this magnificent environment are of designs which have established new standards of construction and service.

Throughout the country many of the existing broadcast stations have been improved in various particulars during the year. There is much more to be done along this line in the months to come.

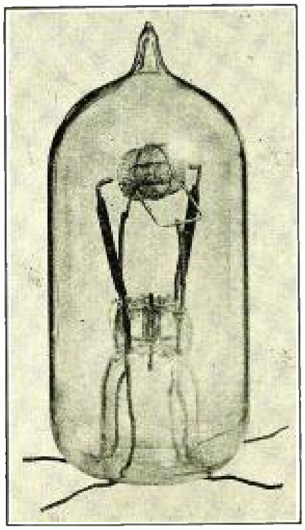
Radio Receivers

The invasion of the market a year or more ago by the midget, low priced, universal receivers required the manufacture of many new component parts—coils, condensers, loudspeakers, resistors, and a host of other accessories, all of which had to be given smaller dimensions. The reception accorded the miniature sets influenced somewhat designs to meet other needs. Design also was influenced by new lines of vacuum tubes designed to give improved performance in midget and mobile receivers, also by tubes having multi-function capabilities.

There was also the increasing popular interest in short-wave reception, the result of which was the widening of the frequency range of every model except the automobile receiver and one other to include one or both of the police call bands—that is, from 1500 kc. to 1700 kc. or 1500 kc. to 2800 kc. In addition, two types capable of receiving foreign short-wave broadcasts were developed. One of these was an all-wave receiver with a frequency range of 540 kc. to 18,000 kc.

Shadow Tuning

For use in the tuning of radio receiving sets, a shadow instrument was devised, the variation in tuning being indicated by the narrowing or widening of a shadow cast by a magnetic vane on a ground-glass screen.



G. E. ultra-short wave oscillator tube.

Vacuum Tubes

High-powered broadcast transmitters used to date have included d-c. motor-generator sets which supply the relatively low voltage and high current necessary to light the filaments of the high-power vacuum tubes. Direct current has been necessary to operate these filaments since filaments operated by alternating current in these large tubes produced a low-frequency hum on the carrier output which was annoying when picked up in broadcast receivers. During the year, a method was developed of using alternating current on the filament of large transmitter tubes which suppresses this hum to a point which is not objectionable.

The advantage of this, from the viewpoint of the broadcast station operator, is the elimination of motor-generator sets with their attendant upkeep and the substitution of transformers which are simple, less expensive, and require practically no attention.

The ultra-short wave oscillator tube was designed for use as an "electronic oscillator" where the frequency of oscillation is a function of the time of transit of the electrons. An output of approximately one watt can be obtained at frequencies of 70,000,000 cycles per second.

The design of three-electrode, water-cooled vacuum tubes was carried to unusually small dimensions to secure relatively high output power at very high frequency. The filament leads are located at the top and the grid lead at the bottom. Output of several hundred watts can be secured, at frequencies as high as 300,000,000 cycles per second, using two of these Pliotrons in a balanced circuit.

The use of graphite as an anode material was extended. Graphite has a number of advantages over the materials commonly used in the past for the manufacture of anodes and these new anodes approach black body radiation in their ability to dissipate heat. Therefore, increased factors of safety have been secured in the operation of these tubes.

Aircraft Radio

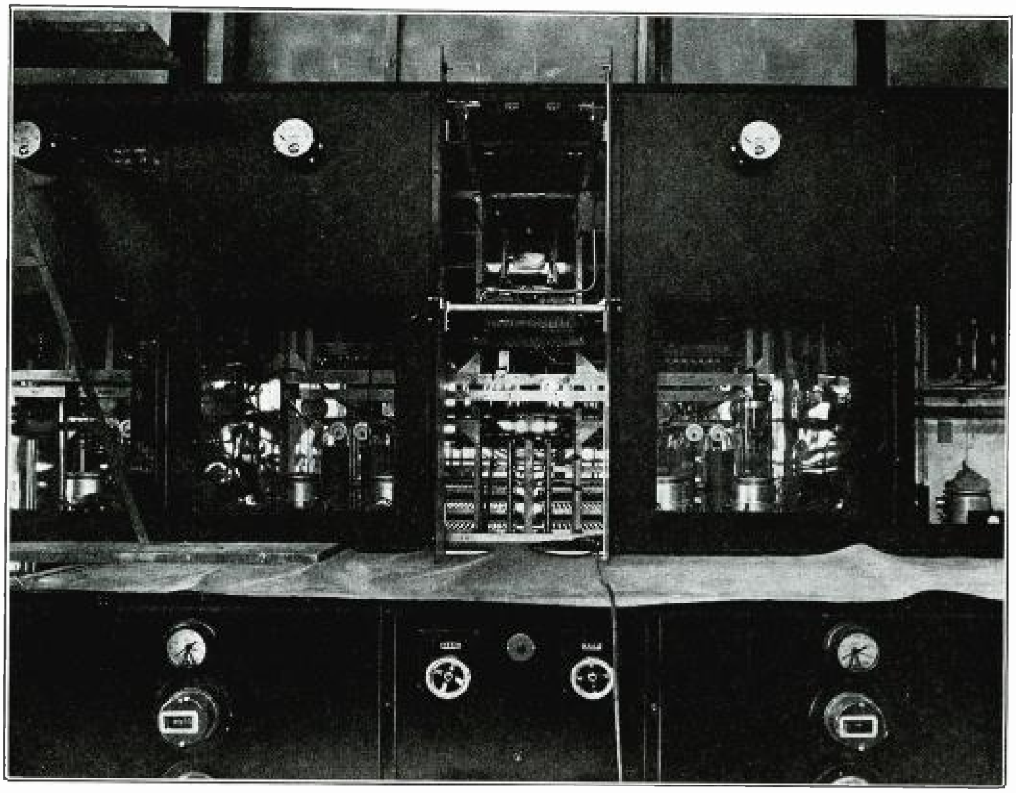
A number of existing radio-range beacon transmitters at major airports were modified to utilize vertical-type radiators in place of cross-loop radiators. In service, the direction of the beams from the cross-loop radiators was found to be erratic at night. Goniometers and antenna tuning units were produced by General Electric in cooperation with Department of Commerce engineers.

Considerable developmental work was found necessary in order to produce equipment which would maintain the proper phase relation of the antenna systems so as to obtain the required directional features. Artificial lines or phase-variation networks were designed which are used to set up conditions necessary for the maintenance of phase stability in the antenna system.

Coupling units were also evolved which are used to operate the antennas in phase for nondirectional communication purposes.

An improved 75-watt aircraft transmitter was developed. This equipment will operate in either intermediate-frequency or high-frequency bands and is so designed that the desired frequency in either band may be quickly obtained by means of controls on the front of the panel. Even though the equipment is extremely small for the amount of power delivered, the design is such that it was not found necessary to resort to plug-in coils. These transmitters are intended expressly for use on the larger Coast Guard amphibion "hospital" planes which have already functioned in many heroic rescues at sea.

FIVE HUNDRED KILOWATTS AT WLW



A Unit at WLW.

HERE is the first photograph to be taken of one of the three super-powered radio-frequency units which are to be part of the mammoth broadcast transmitter plant now nearing completion for the Crosley Radio Corporation station WLW.

Each of these giant units has a power rating of 180,000 watts, more than three times greater than that of any commercial radio station now in use in the United States. When completed the new transmitter will provide the most powerful signal ever produced.

The radio-frequency unit illustrated herewith stands 16 feet in height by 10 in width and is a part of a 54-foot main transmitter panel. Each of the units contains four 100,000-watt tubes, one of which can be seen in place at the right. Part of the grid tank circuit and filament switches are to be seen through the open door. Incidentally, this door is electrically interlocked in such a way that when opened the unit is automatically isolated and all power cut off. Thus, should trouble develop in any of the units adjustments may be made while the remaining two units keep the station on the air with but slightly reduced signal strength. The safety bar to be seen across the door is an added precaution for mechanically disconnecting and grounding circuits.

The unit's controls are to be seen in the foreground on the panel below the cat-walk while on either side are the water flow meters and temperature control meters.

Radio equipment for the station was designed and built in collaboration with the Westinghouse Company and RCA-Victor. This is the highest output power used in any broadcasting station in the United States. The unmodulated carrier power delivered to the antenna will be 500 kw. and instantaneous power on peaks of modulation will be 2000 kw. There will be approximately 74 tubes in the complete transmitter including 32 tubes in the existing 50-kw. transmitter.

The control circuit was designed for complete automatic operation and for any desired degree of manual control by means of 30 centrally located controls on the operator's control unit which has 35 lights to indicate the operation of the various circuits.

The audio output delivered by the modulator will be approximately 165 decibels above the output delivered by the microphone. This represents a power amplification of 7×10^{16}.

The high-voltage plate rectifier was designed for a continuous output of approximately 100 amperes at 12,000 volts and a capacity of 220 mfd. is used in the main rectifier filter. The 4,000 amperes of filament current for the 20 power amplifier and modulator tubes is carried by copper buses having a cross-sectional area of four square inches. Twenty thousand cubic feet of air per minute are required to cool the new transmitter. The station will be placed in regular operation early in 1934.

LOOKING AHEAD IN THE BROADCAST FIELD

By D. E. Replogle*

The following is a paper delivered at a meeting of the Association of Broadcast Executives, at Buffalo, N. Y., December 7, 1933.

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WHAT of the future? Will the present allocations stand? Will the present broadcast power maximums be maintained? What new developments in the near future will effect the course of radio broadcasting? Let us consider some of these questions.

There is a turn on the part of the public and the manufacturers away from the cheap receiver, exemplified by the a. c. - d. c. radio sets with their poor quality, and the trend toward higher quality receivers as witnessed in the advertising of leading radio set manufacturers.

The old receivers with their 200 to 4000 cycle range are obsolete and the order of the day is for receivers that will faithfully reproduce between 80 and 6,000 cycles. With these new receivers the public is learning to distinguish the difference between stations. This means that those broadcast station operators who are taking a long range view of their industry will realize that station improvement is paramount.

The station which broadcasts the best quality will be the station which will have the best and largest audience—the station that can sell its programs with the least effort and for the most money.

To own such a station attention must be directed to technical matters which often irk the broadcast station owner but which cannot be neglected if a station is to rank high in its appeal to the American Public.

First, the operation of a station's equipment must be of the highest quality and I wonder how many executives have given their operators equipment capable of giving the results required? Do your operators know how to use Class B modulation so that they can obtain economy in tube consumption without deteriorating the quality of broadcast service?

Do you realize what 100 per cent. modulation truly means? Do you know that with low modulation you are not making the best use of assigned power, but that with more than 100 per cent. modulation on peaks the quality of broadcasting will be greatly impaired, even with the finest transmitters?

To those stations which have achieved a degree of excellence in operation and output quality, one thing will become more and more apparent and the transmission of the Philadelphia Symphony program last April to an audience seated in an auditorium in Washington through a greatly improved transmission system which faithfully transmitted all sidebands from 30 to 16,000 cycles demonstrated, by the resulting high quality, realistic music, that a broadcast system that could transmit a higher number of cycles faithfully would stand out high above some of the present quality of radio broadcasting. It can be expected that increasing pressure from receiver manufacturers and the public for higher transmission quality will appear in the near future.

Regrouping of Frequency Allocations Imminent

To meet these requirements it will, of course, be necessary to have transmitter designs with intermediate buffers and with tube types capable of handling 100 per cent. modulation without saturation, better regulation in power supplies, and the use of high quality audio modulation systems will be essential. But, there will be the necessity for securing greater space in the radio ether.

At present the Federal Radio Commission permits the use of a maximum of 5,000 cycle sidebands, which means that frequencies beyond that are not supposed to be transmitted. However, recognizing the trend for higher quality, leading broadcast stations are actually using modulation frequencies as high as 8,000 cycles and it is understood that the Telephone Company supplies lines which will carry frequencies as high as 8,000 cycles.

All of this points toward the necessity of more space in the ether for those stations which are building up broadcast quality to secure this higher type of transmission.

With pressure for increased space in the ether among our own stations and with the clamor from northern and southern neighbors for more channels, it is reasonable to expect that in the near future radical changes in the broadcast frequency assignments are likely to take place.

The growing conviction that satisfactory service can be given only when the ground-wave field-strength is sufficient to override local noise levels, means there will be a constant tendency toward higher power for the larger stations. With present assignment this means objectionable heterodyning which always has been a serious problem in radio reception.

One aid in clearing up present channels would he the

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*Chief Engineer, Hygrade Sylvania Corp.

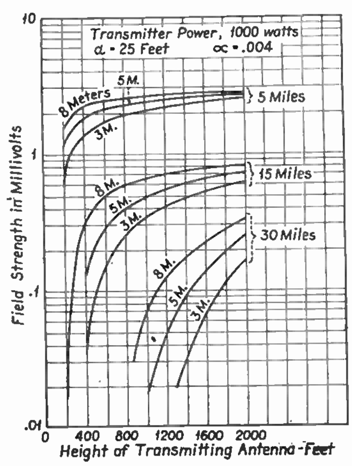


Fig. 1. Full strength versus transmitter antenna height.

grouping of large stations which are operating on the same chains across the country, on a single frequency, and to diminish the possibility of heterodyning between these stations by the use of directional antennas which have been worked out so carefully that the field pattern can be changed at will by proper engineering.

Synchronizing stations on a given frequency has been made possible by new developments. One system is using land lines to control the oscillators of associated stations and a more recent development is the precision frequency-control equipment which can be made accurate to one part in ten million. This equipment will control the various stations on the same assigned frequencies so closely that heterodyning between carriers is undiscernible.

Spacing the powerful synchronized station at 30 to 40 kc. intervals instead of 10 kc. might then be possible. This would permit improvement in audio-frequency fidelity mentioned and would also permit the granting of powers necessary for good ground-wave coverage in the service areas.

Ultra High Frequency Experiments

Dr. Schroter, in Germany, carried out an investigation to determine the feasibility of broadcasting over a locally restricted area with frequencies around 45,000 kilocycles (about 7 meters wavelength). A transmitter of about 300 watts output was set up which rebroadcast the program of the regular Berlin stations. The transmitter was controlled by a crystal having a frequency of about 2,680 kilocycles, the final ultra-high frequency being obtained by frequency doubling. It was found that, with the above power satisfactory reception on simple receivers was possible up to a limit of about 15 kilometers (9.5 miles) from the transmitting station. The attenuation was much greater than would be expected from the inverse distance formula, and was attributed to absorption by the buildings in the solidly built-up section of Berlin in which the transmitter was located. Dr. Schroter found that the attenuation of the signal in Berlin averages one neper per half kilometer, which may be stated as 30 db. per mile.

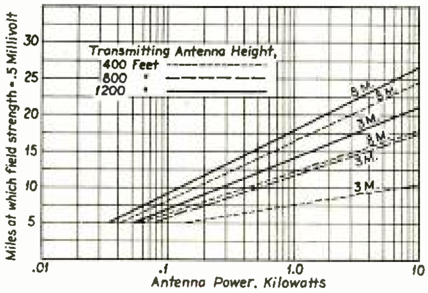
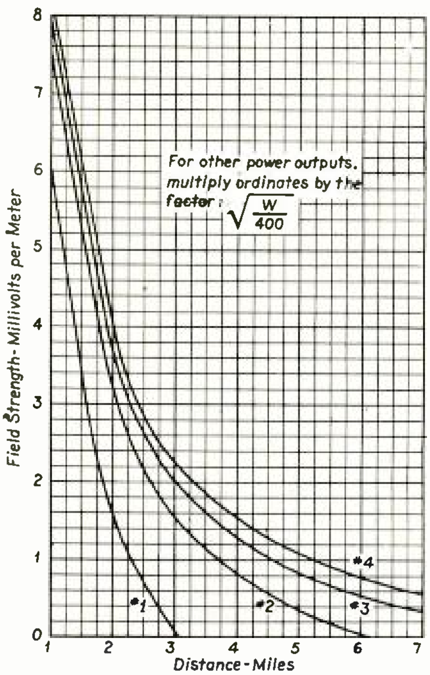


Fig. 4. Half-millivolt range versus kilowatts.

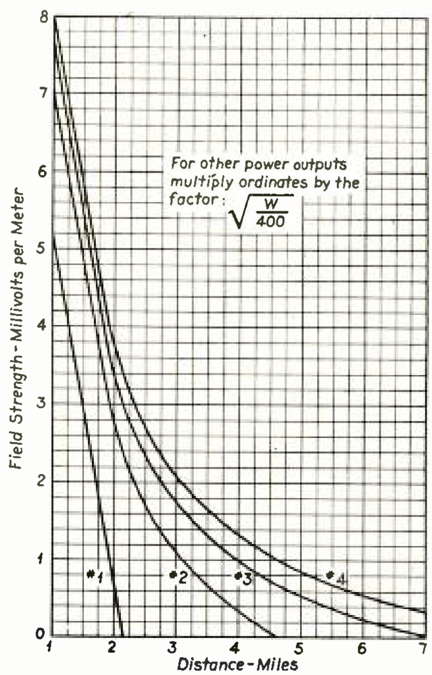
The Phillips Company in Holland, commissioned Dr. P. J. H. A. Nordlohne to make an experimental study as to the feasibility of broadcasting on ultra-high frequencies.

Dr. Nordlohne makes several observations which I should like to emphasize, because it is precisely these points which make the ultra-high frequencies attractive as a *local* transmitting medium. The transmission is necessarily local because (1) the direct ray cannot follow the curvature of the earth's surface; (2) vibrations of such high-frequency are not reflected from the Kennelly-Heaviside layer, so that there is a complete absence of any sky-wave. This absence of a sky-wave prevents fading, and accompanying distortion. The experimental work indicated that up to a few miles the condition of the atmosphere plays no part in the transmission. The ranges obtained around Amsterdam were about the same as reported by Dr. Schroter for Berlin. It is pointed out that there is a complete absence of the ordinary back-



At left: Fig. 2. Field strength versus distance ultra - short waves. Output power: 400 watts. Wavelength: 10 meters. No. 1. Transmitter height —50 feet. No. 2. Ditto—100 feet. No. 3. Ditto—150 feet. No. 4. Ditto—200 feet. Data computed from formulas of Jones (Proc. I. R. E. 21, p. 832, March, 1933).

At right: Fig. 3. Field strength versus distance ultra - short waves. Output power: 400 watts. Wavelength: 7.5 meters. No. 1. Transmitter height —50 feet. No. 2. Ditto—100 feet. No. 3. Ditto—150 feet. No. 4. Ditto—200 feet. Data computed from formulas of Jones (Proc. I. R. E. 21, p. 832, March, 1933).



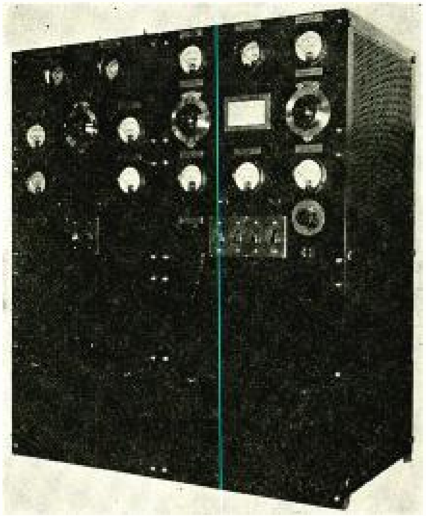


Fig. 5. Model 130B station transmitter.
Power output: 150 w.
Frequency range: 32,000 - 42,000 kc.

ground noise. Automobile sparks proved to be the worst source of disturbance. It was found, however, that judicious insertion of resistances in the automobile wiring system, together with a shortening of wires which might be expected to act most efficiently as antennas brought the noise down to a point where it was not noticeable at distances greater than 10 feet. Due to the attentuation caused by the building, the range is also less than the theoretical horizon. The transmitter was crystal controlled at 38,400 kc.

After preliminary development charges have been absorbed, the cost of such a transmitter would be no greater than that which would be expected for the same power in the present broadcast frequencies.

In this country, broadcasting from the Empire State Building on frequencies around 61 mc. or five meters, and the various experimental stations set up in Boston, Bridgeport, Worcester, Mass., Elizabeth, N. J., East Orange, N. J., and Teaneck, N. J., have proven conclusively the value of ultra high-frequencies for local coverage when intelligently used.

In these cities, reliable reception was experienced, depending upon the height of the transmitting antenna and the power, up to a maximum of 12 miles for a 100-watt transmitter.

This reception was experienced in a car with an antenna limited in height. Considerably better results are to be expected from fixed, high antennas which are practical for reception of radio broadcasting in a home.

At these frequencies a number of problems have been encountered such as interference caused by automobile ignition systems and the phenomena of standing waves which give a minimum of signal strength in certain restricted spots.

In regard to the first limitation, an effort is being made on the part of the radio manufacturers to interest automotive engineers in taking the simple means of eliminating ignition interference in their automobile product at the factory.

At these frequencies little atmospheric disturbances are observed and the amount of natural static is almost negligible.

Regarding the second disadvantage it is easy to eliminate the dead spots which are very restricted in area by the placing of an antenna in different positions and it is always true within the limits of the number of positions which can be utilized for a receiving antenna by a broadcast listener.

The major advantage, however, of these ultra high-frequencies is that they occupy a particular part of the spectrum which is now uncongested and there is so much room in the ether that a number of stations could be placed in this part of the spectrum without overcrowding, and due to the fact that these frequencies do not carry beyond the visual horizon and are not reflected back to earth from the Kennely-Heaviside layer, they are definitely restricted to a given locality and duplication of wavelengths at intervals of 100 miles can be made without fear of interference and its resultant heterodyning.

Given this wide space in the ether for high quality, wide sideband radio broadcasts, because of the small dimensions of a half wavelength radiator, it is possible to erect even high-power stations at a minimum of cost and to provide multiple antenna systems or directional rays to allow for topographical peculiarities at the transmitter or in the receiving area.

Some use has already been made of these ultra high-frequencies by the broadcast fraternity because of the small dimensions of a reasonably powered set for remote pickup work for present broadcast stations.

It is entirely feasible with a small 15-watt or 25-watt portable transmitter to place it in an advantageous position and pick up broadcast material and transmit it to the central station from which it can be re-broadcast in the usual manner. Such a system is now being built for a station which is faced with the problem of picking up race results from a track ten miles distant and from which there is no telephone service.

One good high-frequency transmitter can be used for the pickup transmitter and a smaller transmitter can be used on another frequency as an order circuit link.

A still further use of the ultra high-frequencies is even now in use—namely, the equipping of a cruising automobile with a broadcast set which will enable it to follow parades or rush to the scene of news interest and report back instantaneously from the ground.

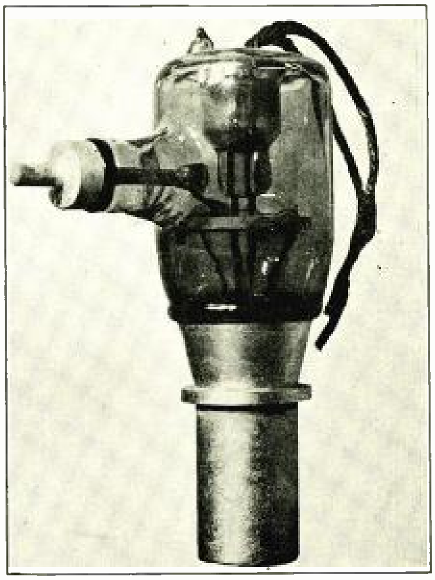


Fig. 6. Type 846 ultra-short wave tube.
Normal power output: 1,000 w.

Reception Possibilities

While the super regenerative receiver is in demand for reception of these frequencies, strides have been made in the development of a high-frequency superheterodyne which will have excellent frequency characteristics and equally good sensitivity and selectivity.

One of the problems in this receiver has been making a stable oscillator. Another difficulty has been the development of a loudspeaker which would faithfully reproduce all frequencies of the higher overtones up to 16,000 cycles. The crystal loudspeaker in conjunction with the dynamic speaker has been used to give exceptionally good results and can be said to be faithful to these high frequencies with moderate power.

Experiments carried on in reception show that where the signals are received in a local area, they are steady and subject to no static other than man-made. They are capable of being used for very high quality voice reception. Because the ground-wave alone is used, there is no phase fading and no varying in the signal as is often observed from even the highest powered stations.

This will be an opportunity for the set manufacturer to develop a new receiver in conjunction with the present broadcast receiver for the reception of ultra high-frequency wavelengths.

The accompanying graphs will give an idea of the magnitude of the field strength as a function of antenna height, antenna power, and distance between the transmitter and the receiver. There are shown the average results obtained by Jones as reported in the Proceedings of I. R. E. for March, 1933. In examining these curves, it should be kept in mind that a signal level of 1 millivolt-per-meter is necessary for reliable reception. It should be further understood that on account of absorption and interference effects, large deviations from these average values may occur at different locations in the same room.

The utility of the ultra-short waveband for police use, particularly in connection with two-way communication between police cars and the central office, has already become apparent, and several installations have been made in eastern cities.

As might be expected, progress in the ultra high-frequency field has necessitated the development of new tubes having characteristics particularly adapted to the high-frequencies. Fig. 6 shows the 846, a water-cooled tube especially developed for the power output stage of ultra short-wave transmitters. Two of these tubes will deliver 1,000 watts of carrier modulated 100 per cent. in the ultra high-frequency band.

Fig. 5 is a view of a model 130-B transmitter unit. This unit has a power output of 150 watts, and a frequency range of 32,000-42,000 kilocycles. Standard construction is followed throughout and accessibility of the various elements is provided for by liberal dimensions and spacing. The equipment includes a complete complement of meters and controls.

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Phase Modulation and Frequency Modulation

THE expressions phase modulation and frequency modulation are sometimes used interchangeably. It is true that they have much in common, in particular from the point of view of distortion. As long as we confine our interest to the *effect* of the distortion, once produced, the distinction is doubtful in value, if not quibbling in nature. The fundamental reason for the distortion is a rate of change of phase or frequency—call it what we will—which results in distortion when two components differently delayed, are recombined at the receiver.

When, however, we direct our attention to the *cause* of the distortion, it is often useful to differentiate. In the first place, there are types of transmitter defects (such as coupling from the output back to frequency-controlling oscillator) in which the frequency may be expected to vary through the modulation cycle and in such a way that the frequency is a function of the amplitude of the output. Here only the instantaneous *amplitude* of the audio wave is a determining factor of frequency. In the second place, there are defects in which the frequency of the control oscillator is held rigidly constant, but with different amplitudes different relative phase shifts are produced between that oscillator and the antenna. The latter might, for example, be produced by the impedance of one element of the circuit (e. g., an amplifier) changing as a function of input. In other words, the frequency in the first case and the phase in the second, are functions of the instantaneous amplitude of the modulating envelope. The existence of these two more or less distinguishable types of defect seems sufficient justification for the use of the distinguishing names, "frequency modulation" and "phase modulation."

While we are discussing this from the point of view of distortion, the distinction seems particularly fitting in view of the fact that it coincides with definitions made previously in connection with these phenomena as a means for, rather than as a hindrance to, communication. The difference is illustrated in Fig. 1, in which a wave of constant amplitude is modulated first in phase, and second in frequency, by the same square-topped modulating wave.

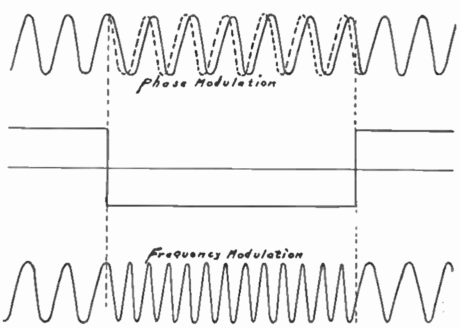

Fig. 1. A wave of constant amplitude modulated in phase and in frequency.

Neither phase nor frequency modulation can be found by simple detection. The phases and amplitudes of the many components are such that the result with a square-law detector is the same whether or not the phase is modulated. When, however, the wave passes to the receiver along several paths of widely different optical lengths (as measured in wavelengths) this nice balance of detection products is destroyed. The result is that harmonics of the *pt* term appear in the output while the amplitude of the *pt* term may be reduced to small values. It should be possible to detect phase modulation locally if a sufficiently selective frequency analyzer were available.—*The foregoing is from an IRE paper by J. C. Schelleng entitled "Problems in Telephone Transmission."*

What Radio Engineers Are Thinking and Talking About

C. M. JANSKY, JR.
President, I. R. E.

AT the regular meeting in New York January 3, of the Institute of Radio Engineers, the inability of the author of the paper of the evening to be present, was taken advantage of by President Jansky to throw the meeting open to a forum discussion of whatever occupied the minds of the several hundred engineers present.

Mr. Jansky at some length went into the subject of the rating and qualifications of radio engineers. He presented a review of procedure in the associations maintained by members of other learned professions, such as the American Bar Association and the American Medical Society. It was his opinion that so far as radio engineers identified with broadcast construction and operation and those employed in the design and manufacture of radio receivers are concerned, that many of them are far from well qualified to do the best work. A reason for this situation may be that economic conditions plus the highly competitive nature of the industry during recent years, wherein the demand has been for low cost manufacture and minimum of overhead, has relegated engineers to posts where they serve largely as copiers, as mechanics and as assemblers. Mr. Jansky has had the thought that the employers have no sure guide to aid them in determining the fitness of applicants for radio engineering positions. This, he thinks, may be a matter for consideration and action by the Institute.

Other members present expressed the view that the radio art is still young and that the attitude maintained thus far by commercial interests toward radio engineers is unavoidable in a new industry. The fact that in the main men graduated from the universities and colleges, who have specialized in radio, receive degrees which do not in present forms convey assurance of a knowledge of radio engineering, presents a lack which in time may be supplied.

Some of the engineers, recognized as successful, state that the term "fundamentals of radio" must soon be realized as covering a much wider base than was contemplated a few years ago. This, as a result of extensions, expansions, and a broadening of the applications of radio and radio devices.

After the economic adjustment of 1930-1934 has accomplished its purposes, which may be in the nature of a national brake test, a radio engineer may have high standing as an expert in any one of a dozen departments of development or application, without being expected to be expert in all departments. This outcome would follow experience in other professional lines, particularly in medicine and in law.

At the meeting referred to there was a frank and open discussion bearing on the merits or lack of them in present day radio receivers. A thought generally expressed was that the prospective purchaser of a broadcast receiver has not been given understandable standards by means of which he may judge excellence. Sales methods which have been customary thus far in the radio industry have been successful somewhat in proportion to the individual salesman's rhetorical ability to enlarge upon the features of "distance," "tone" and "volume" possessed by a particular receiver on which the possible purchaser has his eye—or his ear.

If the salesmen understand the virtues of wide frequency range, selectivity and distortionless volume control, naturally they would be loath "to bring that up"—unless with a view to taking advantage of gullibility. Obviously, the price market which has continued throughout the past three years had to be met, and the totals of receiver sales for the period indicates that it was met by the manufacturers. No one doubts that had there been on the market only high grade receivers having wide frequency range, true fidelity, close selectivity, automatic volume control, good appearance and liberal dimensions, the unit sales would not have been so large.

A result of this sales situation was clearly outlined by Mr. Jansky when he related that recently a survey he made satisfied a sponsor that a certain broadcast station had a territory coverage which comprised several hundred thousand receivers, but that when the sponsor asked the question "How many of those receivers are capable of properly reproducing the music from a symphonic orchestra as sent out by this broadcast station?" the truthful answer had to be "Very few of them." Thus, viewed as a system—transmission and reception—the receiver has not in a large enough spread kept up with the broadcasters.

Improvement in purchasing power on the part of the populace might be expected to remedy this situation to a considerable extent, but the engineers still think there should be worked out some form of authentic receiver branding which would assure the purchaser that he is or is not buying a radio receiver and not (as Dr. Goldsmith characterizes some products) a "Howlodyne."

In the discussion on this subject, C. W. Horn, technical head of NBC observed, possibly humorously, that a *Good Housekeeping* "OK" for radio receivers might serve a useful purpose. The problem is, however, one for the engineers and the sales executives of the radio industry to iron out.

Some of the Problems of MOTOR-CAR RADIO DESIGN

By Fulton Cutting and H. A. Gates*

THE designer of a motor-car radio must surmount many problems not encountered in the design of a receiver intended for home use. In a general way the problems may be fitted into one of five approximate classifications:

Those occasioned by the necessarily small antenna and consequent small signal pickup; those due to ignition; interference; acoustic problems and the problem of satisfactory power supply; those resulting from the severe mechanical and physical requirements and limitations.

Quite often an apparent solution of one of these problems is not a solution because it throws the problem into another classification.

The Small Pickup Limitation

The average car antenna appears to be about one-twentieth as effective as the average antenna installed at a home. That would make it a one-fifth meter antenna, compared to a four meter home installed antenna. In a field strength of 100 microvolts per meter, 20 microvolts would be applied to the input of the receiver. Thorough tests indicate that an average output of from 2 to 2½ watts of audio power is necessary for satisfactory automobile radio reception. This large value, considering the small space in which the sound is confined, is made necessary by the high noise level existing in a car. Even in the newest of cars and over good roads, the noise from the car motor, car rumbles, and wind bring the noise level to quite a high value. To obtain the necessary 2½ watts of power, a gain of about 355,000 times or 111 db. is necessary.

This high gain must be obtained with a minimum of tubes for two reasons. The drain on the car's battery must be kept as low as possible, and tube hiss must be kept low so that it does not add to the problems of building a receiver that must be quiet even though operated near a veritable "noise factory," the car's ignition system. Accordingly an input coil is called for having the highest possible gain. The use of litz wire in a properly designed coil makes it feasible to secure a gain of from 20 to 24 db. This high gain, in effect, makes the small car antenna much more nearly the equivalent of the larger home installed antenna. Litz wound i-f. transformers also help to squeeze every bit of gain possible out of the other tubes and stages.

Because the car antenna can easily become shielded when the car is near large steel structures, the avc range of an automobile receiver must be as wide as possible. Even without the abnormal shielding effects of steel structures, field strengths can change greatly in the distance covered by a car in only a short time of driving. Tests have shown that an avc range less than about 40 db., a 100:1 ratio is not sufficient for satisfactory reception.

It is desirable to have the avc circuit incorporate a "squelch" or delay feature. With such a system, there is no response until a carrier of sufficient strength to insure good reception is tuned in. Unwanted weak stations and noise are eliminated.

*Colonial Radio Corporation.

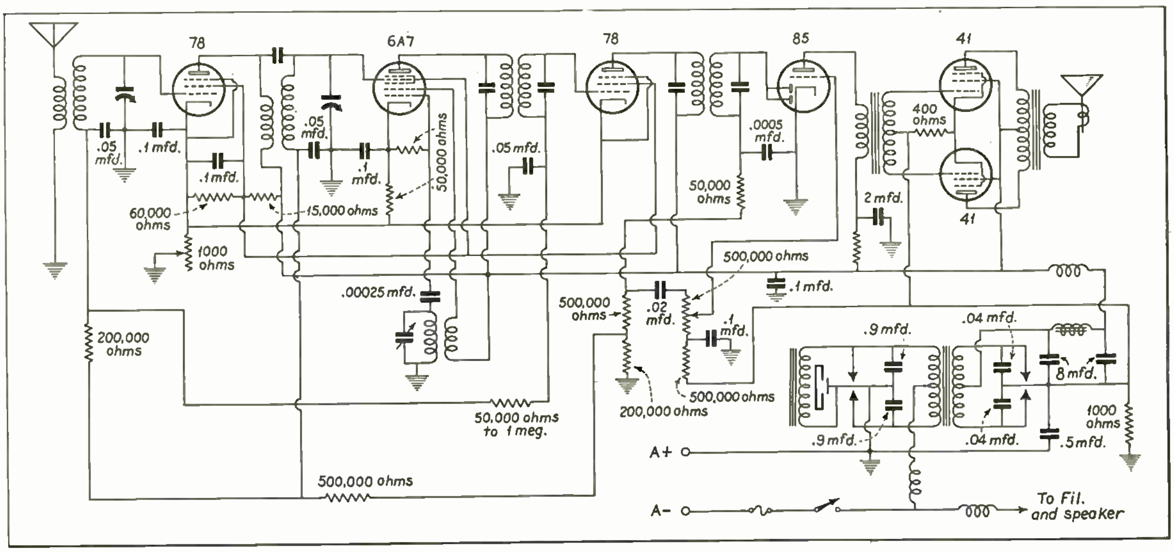

Fig. 1

Ignition Interference

One of the hardest problems of motor-car receiver design has been that of successfully operating so sensitive a receiver in the very intense field set up by the car's ignition system. This interference field has two sources:

The primary circuits of the ignition system, and the high tension secondary circuits.

Contrary to popular belief, the primary circuit is the worse offender. The instantaneous currents in it are so high and resultant fields so intense that they induce disturbances in neighboring circuits. The suppressors used on spark plugs actually serve to quench r-f. disturbances generated in the secondary circuit. The distributed inductance and capacity of the high-tension circuit put any disturbance *directly* created by it far outside of the broadcast band. The suppressors are effective because they modify the abrupt rise and fall of current in the primary thereby preventing the primary from shock exciting receiver circuits.

Disturbances may be radiated by any metal object in the car. The car wiring, gas and oil pipe lines, and control levers and cables are the most obvious mediums. These disturbances can be fed into the receiver in one of three ways: antenna pickup; through the "A" cable, and coil, lead, and chassis pickup.

Antenna pickup is an installation problem rather than a design problem. Almost always it can be overcome either by shielding or by the use of r-f. filters, or by both. Chassis pickup can be prevented only by very complete shielding. Interference can get through even a crack or small hole and if a grid lead is near, the noise will be amplified. The shielding *must* be thorough. Because of the intense interference field, all parts of the shielding case and chassis cannot be considered at ground potential. Circulating currents exist in the shielding and chassis and care must be used in making the different ground connections of the circuit not to have these circulating currents fed into the amplifying circuits. Care must also be used to prevent the creation of balanced bridge effects. That is, pickup in one place balanced out by opposite phase pickup elsewhere. Such design makes a nicely working laboratory model, but one which is difficult to duplicate in production (or even in the laboratory).

Power Supplies

There are three types of power supplies available for converting the 6-volt power of the car's battery to approximately 250 volts for the plate and screen circuits: dynamotor; buzzer or vibrator and tube rectifier, and buzzer or vibrator and mechanical rectifier.

Obviously, the lowest possible battery drain is to be striven for so that the car battery and generator will not be overtaxed. To attain this end, efficient power supplies and multi-purpose tubes such as the 6A7, 6B7 and 75 should be used.

The dynamotor, when well built, is desirable from the standpoint of dependability. However, its efficiency is lower than that of the other two types of supplies and its cost is higher. Average efficiencies run between 25 per cent and 45 per cent. Its starting current is perhaps three times greater than its normal current, making proper fusing difficult. Easier filtering of its output might be mentioned in its favor.

The vibrator type, in which the primary of a differential step-up transformer has its circuit interrupted by a vibrator and its stepped up secondary voltage rectified by a tube and filtered, has been developed to the point where it is satisfactory, commercially. Many problems had to be overcome. Chiefly they were the ones of proper contact-point design and the elimination of sparking at the points. Unless properly designed, vibrator type power supplies creat intense r-f. disturbances which are picked up by the receiver making satisfactory reception impossible. The efficiency of a good unit runs quite high, perhaps 65 per cent.

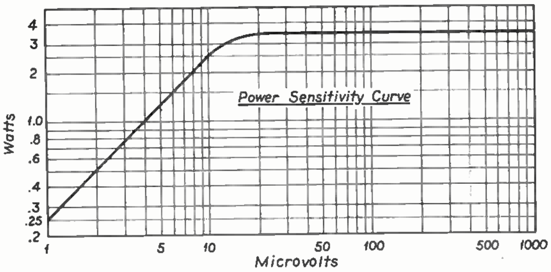

Fig. 2.

The vibrator type which uses another synchronized vibrating reed to provide rectification has the highest efficiency, in the neighborhood of 69 per cent. Because this type has an additional vibrating reed and additional contacts, and proper synchronism with the primray vibrator is essential, commercial development of this type of supply has been difficult and has come later than that of the other types. However, there are now available satisfactory units of this type. Their high efficiency, freed from the necessity for tube replacement, and their compactness makes them very desirable.

Under varying conditions the car battery voltage may have any value between 5.5 volts and 9 volts. The power supply must be so designed that it operates properly over this voltage range. Receiver circuits, particularly the oscillator, must be designed to have as little frequency shift with voltage change as possible. Tube manufacturers have cooperated by designing tubes that work efficiently over a wide range of heater voltages.

The Acoustic Problem

The acoustic design of a motor-car receiver is difficult for two reasons. Because of space limitation, sufficient baffling to secure good low note response is almost impossible. It has also been found that high-frequency absorption is very pronounced in automobiles. By matching the resonant frequency of the speaker to the effective baffle, both low and high note response is greatly improved over that obtained by resonating the speaker for low frequencies.

The Physical Requirements

The smaller a motor-car receiver can be made the better, if its small size is not accomplished by sacrificing other desirable characteristics. Car occupants' leg room must not be encroached upon and room must be left for the installation of car accessories, such as heaters, fans, etc. The design must be such that extreme mechanical rigidity and strength is provided. An automobile receiver is subjected to very severe vibration and jolting and to wide variations of temperature and humidity. The temperature at the bulkhead of a car attains surprisingly high values. Not infrequently a heater is mounted on the bulkhead immediately alongside of the radio receiver. The circuits must stay in align-

(Concluded on page 22)

Is Competition in Communication to End?

Will Government Urge Radio and Wire Companies to Combine?

IN the communication business as in other commercial undertakings, when business is good, employment large, and dividends are paid regularly, there is little or no talk of consolidations of competing companies. When dividends are imperiled, reduced or stopped, the owners (stock and bond holders) have an open mind on the subject.

As a political football the wire communication companies were in for it as soon as it was worked out that radio telegraphy could compete with submarine telegraph cables across the oceans, even if for a long time the owners of radio received little or no returns on their investments.

In 1915, while Mr. Vail was still the directing head of the telephone company (A. T. & T. Co.) the view of the company with respect to radio communication was that "The great obstacles to dependable usefulness with commercial possibilities—the causes which confine this great achievement to particular undependable uses—are natural conditions as yet and probably forever uncontrollable."

At that time, and thereafter until recently the views of wire telegraph and telephone interests, and of the legislators who framed the laws under which the Federal Radio Commission operates, were that there seemed to be no sound reasons for duplicating existing wire service links by setting up radio links between the same points: that radio telegraph or telephone links were warranted economically only where the maintenance of wire or cable lines was not practicable, and for ship-shore, army, navy and mobile uses.

Events which occurred which altered somewhat the views with respect to radio were the discovery thirteen years ago that there is a vast field of usefulness for an entirely new, a one-way communication service, (broadcast radio telephony); later the inauguration of trans-Atlantic and trans-Pacific radio telephony, and the astonishing advances made in short wave radio telegraphy.

Notwithstanding that radio engineers from time to time accomplished results which a decade previously were looked upon as impossible of attainment, the number of radio channels available has been very far short of what should be required to carry on even trunk telegraph and telephone service overland, with the present traffic. This, aside from the question of comparative costs of operation.

There has been a growing feeling that henceforth there will be a decreasing amount of wire line extension, and that as an auxiliary service radio, both telegraph and telephone, will increase in application. There are many problems bound up with this idea, but these are not so plain to legislators as to construction engineers and traffic engineers, long engaged in communication work.

In normal times the two telegraph companies have handled as many as two hundred thousand telegrams per day into and out of New York City alone.

The daily press of today contains occasional articles, presumably originating in governmental circles, to the effect that there are moves afoot to foster consolidation of the operating plants of the Western Union and Postal telegraph systems, with RCA communications playing some part in the get-to-gether. It will be interesting to follow the arguments of legislators who favor the combine and those who oppose.

The Western Union

In organization, the immediate predecessor of the Western Union Telegraph Company was the New York and Mississippi Valley Printing Telegraph Co., the name being changed in 1856. The company paid its first dividend in 1857. In 1866, the United States Telegraph Company and other independent lines combined with Western Union and the headquarters was moved from Rochester, N. Y., to New York City. From 1872 the gross earnings of the company grew from $8,500,000 to considerably over $100,000,000 per year.

Thus, the company grew until the advent of the Postal Telegraph-Cable Company as a powerful competitor.

The Postal

The company was organized in 1883 and two years later absorbed The United Lines Telegraph Co., and the Bankers and Merchants Company's lines. Associated with the Commercial Cable Company's extensive system of submarine cables, and the Canadian Pacific Railway Company's large telegraph system in Canada, the Postal made rapid progress, building several long trunk lines east and west, north and south in the United States.

Prior to this company's passing into new hands a few years ago it had no bonded indebtedness and had paid dividends on both preferred and common stock for many years. It was conservatively managed, its management at no time aiming to measure up to its powerful competitor in number of offices and in plant.

Upon the acquisition of the company by new interests a program of expansion was entered into which used up so much money that when the depression arrived in 1930, the situation became serious. A bond issue had replaced the original preferred stock. In recent years the $1,000 bonds sold as low as $170.00, and are now around $390.00.

Government Ownership

Since, in 1844, the Government subsidized the building of the first telegraph line, there has been a series of proposals looking to government ownership or control of wire lines. In 1884 there was a Senate inquiry with this end in view. In 1901 the United States Industrial Commission, a government sponsored body again carried out an extensive survey looking to government ownership. In 1906, Congressman Smith, of Michigan, aided and abetted by W. R. Hearst, had a bill prepared for this purpose. In 1914 the proposal was again brought forward as a government measure.

On July 5, 1918, a resolution was passed in Congress authorizing the government to take over all telegraph, telephone and radio systems, due to a state of war existing. Postmaster General Burleson proceeded, with

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Filter Systems
For Use With Auto Radio Power Supplies

By John S. Meck

THE type of receiver, the standard of sensitivity and tonal performance, and service for which the receiver is designed—all to a degree determine the choice of power supply and the design of the filter system.

There are two general classes of power supply devices for use with automotive receivers. These same devices have lately become popular for supplying plate voltages from 32-volt sources, and the filter systems are basically the same, although mechanical considerations differ.

On the surface the raw unfiltered voltage output of these two devices, the vibrator or buzzer unit and the motor-generator, appear to be quite similar. Although both are unidirectional pulsating potentials, the differences that are present establish distinct requirements in the filter systems.

An examination of their output voltage wave shapes, shown in the diagrams, explains the basis for this difference in the filtering problem. Although the "buzzer" type unit has been widely employed, in some respects a completely satisfactory filter system has not been attained on an economically practical basis.

On the other hand, the motor-generator offers a relatively simple filtering, or more truly speaking, "smoothing" problem. This ease of filtering makes possible a very low-cost power supply when both power device and the associated filter system are considered as a unit.

The raw rectified output of the buzzer as seen in the diagrammatic curve has a voltage peak far in excess of the r. m. s. or desired output voltage. Were the wave sinusoidal, the peak would be at least $\sqrt{2}$ times the r. m. s. voltage. Actually the shape is far more peaked and frequently humped on the leading side, even when transient surges are neglected. These transients are present in varying magnitudes, increasing manyfold in case of poor contact point adjustment and when the contacts are worn and dirty. Special consideration must be given in both filter and receiver design to transient surges, as will be considered later.

Another peculiarity of the buzzer system which has been greatly reduced through improved mechanical and magnetic system design, is the fact that the voltage output must return to zero for a period of time between each build-up and breakdown in its highly inductive magnetic circuit. This, despite the most elaborate filtering, results in a fluctuation of potential that noticeably impairs the action of the audio tubes with a consequent destruction of tonal output. Thus the filter system must effectively flatten these high and irregularly formed peaks to a pure d-c. output. This demands a system of large filtering ability (both capacity and inductance) and with ample voltage rating of the capacity units to withstand the high surges.

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An Engineering Comparison of the Motor-Generator and Vibrator Systems of Providing Voltages for Plate Use.

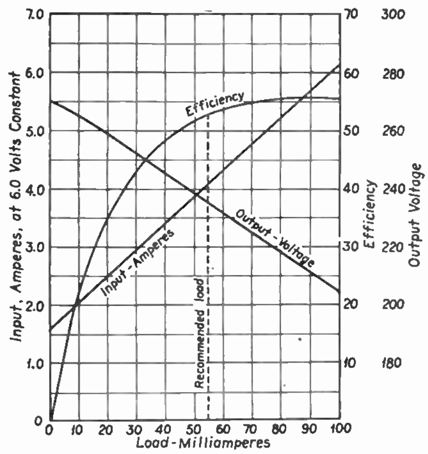

Fig. 1. This performance chart does not include losses due to filter.

Assuming the buzzer to be operating at a rate of 100 vibrations per second, the output voltage is then composed of 200 voltage peaks per second. The frequency of the voltage applied to the filter system is then about one-sixth of the pulsating or ripple component of the motor-generator output. It is quite apparent that increased filtering ability is necessary to smooth a 200-cycle potential in comparison to that needed for the 1200-cycle ripple component obtained at the rotation speeds for which units are designed.

A comparison of the raw output shows that the ripple component peak is only several per cent of the r.m.s. voltage, or in the order of 3 volts for a r. m. s. potential of 225 volts.

Thus the filter system for the motor-generator must flatten out a voltage (purely sinusoidal in shape) of about two or three percent of the desired output voltage, as compared to the peaks of the rectified buzzer output that may be anything from the theoretical 1.41 times the r. m. s. value, up to observed values of 10 or more times the r. m. s. potential.

A worthwhile economy may be made when designing filter circuits for use with motor-generator power devices if it is carried in mind that the differential between r. m. s. voltage and peak voltage in the motor-generator output is only about three volts. This means that electrolytic condensers may be worked safely within five volts of peak rating, which is, of course, much higher than working voltage rating. With buzzer devices, this is not the case; as is described here, the peak output may be several

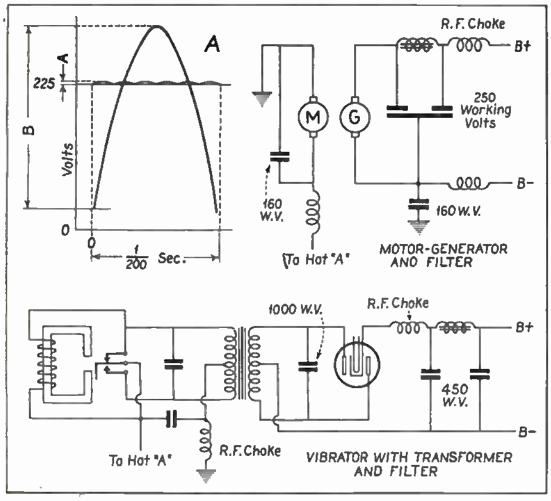

Fig. 2.

times the r. m. s. and voltage ratings for absolute safety should be selected accordingly.

Of equal importance in the filter system design and even in the determination of the receiver by-pass capacity units, are the transient surges mentioned previously. Filter system design that provides for peak voltages equivalent to $\sqrt{2}$ times the r. m. s. output voltage does not take into consideration the destructive action of these transients or the possible peaking of the wave which will send its top far above the peak of a sine shape.

Such transients likewise have a rupturing effect upon capacity units within the receiver circuits if suitable accommodation is not made by the use of abnormal voltage ratings. Much condenser failure in early auto-receiver designs may be traced to these transient surges.

Shown are typical filter circuits for both types of power units. A tabulation of the capacity and inductance units of the filter for each gives an interesting comparison.

Motor-Generator

One 3-5 mfd. 250 W. V. electrolytic unit.
Two .3 mfd. 160 W. V. paper units.
One r-f. choke (Type A).
Two r-f. chokes (Type C)).
One iron core choke (Type B).

Data for Choke Construction

A—60 turns No. 14 s. c. c. layer wound 11/32" inside diameter, 3/4" length.
B—1750 turns No. 33 enameled 1/2" square iron core air gap .002". 90 ohms.
C—150 turns No. 30 s. c. c. 1/4" inside diameter, 1/4" long, random wound.

Vibrator

One .4 mfd. paper 200 W. V.
One .1 mfd. paper 200 W. V.
One .01 mfd. paper 1,000 W. V.
Two 8 mfd. 450 W. V. electrolytics.
Two r-f. chokes, low res.
One 20 mil. H. R. F. choke.
One 300 ohm iron core choke.

If a total is made of the cost of capacity units listed above for the two circuits, it will be seen that the buzzer system requires approximately double the condenser cost. This is not an absolutely even comparison in that the filter circuit shown for the buzzer provides a commercially acceptable output with negligible r-f. content and from .5 volt to 3 volts d-c. ripple depending upon the design and condition of the buzzer. The genemotor filter circuit as shown results in a d-c. voltage with a maximum of 40 millivolts ripple and negligible r-f. content.

By considering the total cost of power device and associated filter system, it appears that there is practically no difference in actual cost of the two power supplies. Freedom from interruption of service then becomes the major factor in determining the choice of unit, Tremendous strides have been made in the mechanical improvement of both the vibrating element and rectifying device of the vibrator units until they are now considerably superior to the early production.

In the motor-generator unit, usually accepted as the most dependable source of power, many years of specialized development have resulted in reducing the mechanical size to equal or less than that of the vibrator type. Likewise, cost has been brought to where it is also comparable.

Radio Announcers' Diction

AWARDS to radio announcers for excellence of diction having attained the state where they may be termed periodical have attracted the attention of the columnist, the etymologists and the doctors of literature. Those who make the awards are being informed that it is pronunciation and not diction that is involved.

Without prejudice to the announcers who have received the awards thus far, Radio Engineering, here, and in this fashion, awards its 1933 palm to Richard Evans, announcer at KSL, Salt Lake City. When Mr. Evans informs his listeners that the light of day has ceased he states clearly that it is dark. He does not ask us to believe that it is "dawk."

We realize that of late on the stage, the talking screen and on the lecture platform, there has been a vogue of cultivating the smooth, mellow pronunciation of the Old South. Radio broadcasting, difficult to sectionalize, carries the engaging utterances of Irvin Cobb and Mr. Kaltenborn to all parts of the country.

It was that eminent son of South Carolina, Ambrose Gonzales, who preserved in several excellent tomes the Gullah dialect, the speech of the people of the black border—a narrow strip of mainland along the South Carolina coast. A sample is "Wuh fuh 'e got nuttin' foh say." Another is "De flowuh 'e grow ebbywuh." And, the Gullah negro rendering his version of a remembered fable, says: ". . . todduh meat in de watuh mo bigguh." Mr. Gonzales in one of his books states that this dialect is "as Africa thinks within these United States."

If Emerson considered all possible circumstances when he said, "We are the prisoners of our ideas," it is possible that ideas which are transmitted through the medium of spoken words would come to us in truer local color, in greater detail, if some latitude were conceded to be acceptable in the matter of pronunciation.

However, so far as radio announcers are concerned in this connection our vote in favor of Mr. Evans remains in the affirmative.

COMMON FREQUENCY BROADCASTING

Stations Which Share Time May By Synchronizing Operate Simultaneously

UPON being brought into the station by wire line the 4 kc. reference frequency passes first through an amplifier. The output of the amplifier is fed into a frequency multiplier which generates the fifth harmonic (20 kc.) of the fundamental frequency. This 20 kc. frequency is used to control a 10 kc. multivibrator. The output of the multivibrator contains the 10 kc. fundamental frequency and all its harmonics up through the broadcast range. The 10 kc. fundamental frequency is passed through one amplifier and the harmonics are passed through another.

The amplified harmonics then are fed into a selector which selects and further amplifies that harmonic which is 10 kc. above the assigned carrier frequency of the station. The carrier frequency, generated by the crystal oscillator, which may be assumed to differ from the assigned value by some difference D is combined with the selected harmonic in a detector.

The amplified harmonic beats with the carrier frequency in this detector producing a difference-frequency of 10 kc.±D. This 10 kc.±D, together with the amplified 10 kc. reference frequency from the multivibrator unit constitutes the input to a pair of balanced modulators.

The 10 kc. reference frequency before being applied to one of these modulators is passed through a phase shifting network which retards its phase by 90°. The output of each modulator becomes one phase of a two phase alternating current of the frequency D. The output of both modulators is then fed into the corrector unit which consists of a small synchronous two-phase motor mechanically connected to a small variable condenser associated with the crystal oscillator circuit. The two-phase current from the modulator stage has a direction of phase rotation which depends directly upon whether the carrier frequency is above or below the assigned value. If the carrier departs from the assigned frequency, the synchronous motor will revolve in the proper direction so that the resultant change in the variable condenser will alter the frequency of the crystal oscillator and so bring it back to the assigned value.

Any deviation of the carrier frequency from the assigned value operates the frequency corrector, providing a precision of carrier frequency never before approached in broadcasting transmitters.

Quartz Crystal Oscillator

The crystal oscillator unit was especially designed for use in this equipment. The equipment contains the crystal oscillator unit and the associated corrector device in duplicate. Should one of the units fail the other may be placed immediately in service by a simple switching operation. The spare unit is kept at operating temperature continuously so that no warming up period is required before placing it in service.

The oscillator circuit, together with its associated quartz crystal control, is housed in a single unit. The quartz crystal control is enclosed in a separate chamber, within this unit. The temperature of this chamber is closely regulated by a mercury thermostat. The circuit, the crystal and the thermostat are adjusted and calibrated as a unit. This insures high precision of calibration as well as permanency of adjustment.

The oscillator tubes used are uniform in construction and, therefore, need not be calibrated individually with the oscillator unit. It is possible even to replace the oscillator tube without appreciable frequency change in the oscillator. The absence of mechanical relays in the crystal heater circuit is an important factor in maintaining satisfactory service.

Advantages of the Equipment

Equipment such as that described has been found the most practical means of holding the carriers of radio transmitters in synchronism. Using the reference frequency to control the output of a local crystal oscillator rather than as the basis for generating the carrier frequency makes the station carrier independent of any interference which might be received with the reference frequency.

This arrangement also insures against the necessity of the station ceasing operation if there is a failure of the synchronizing apparatus or an interruption of the reference frequency supply. Under such conditions the crystal oscillator will continue to supply a carrier which will not drift from the assigned values by more than a few cycles per minute over a period of several hours—a variation which would not be sufficient to cause serious

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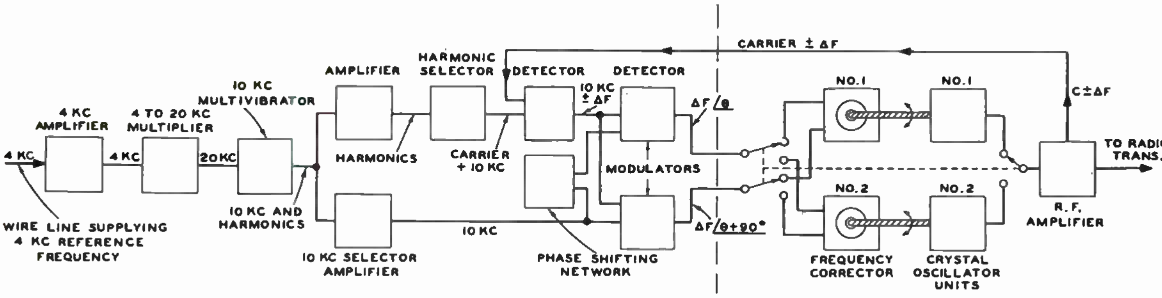

Schematic diagram of Western Electric equipment for common frequency broadcasting.

Fig. 1. The schematic, when studied with the accompanying description, will provide an understanding of the theory of operation of common frequency broadcasting equipment.

HIGH FREQUENCY LIMIT OF VT OSCILLATORS

By Gordon D. Robinson

IT has been observed by the author, and probably by others as well, that when operating oxide-coated filament tubes as oscillators practically at the high-frequency limit of the particular 50-watt tubes, it was a fairly common condition to find that the tubes would operate with reduced filament voltage such as 9 volts when they would not operate with their normal 10 volts.

An alternative to the original guess that this was a gas phenomenon now appears in the information presented by Llewellyn in the November, 1933, Proceedings of the Institute of Radio Engineers according to which power losses occurring in the clouds of electrons within the tube are prominent in the prevention of the oscillation of triode circuits at extreme high frequencies. It appears that the elimination of cathode emission in excess of actual requirements for the anode current should reduce such losses and thus provide a plausible explanation for the favorable results of subnormal filament current.

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AN AID FOR LABORATORY AND DESIGN ENGINEERS

THE most frequent arithmetical computation that radio engineers run up against is that which is required when calculating impedance from known values of resistance and reactance. The computation is simple, merely the determination of the square root of the sum of the squares of two numbers; but when any great number of such computations have to be made the amount of time and the mental energy required become enormous. Engineers who have to make such computations are in agreement as to the tediousness of the task, and any method of procedure, which might cut down the time and effort required, and at the same time give a good degree of accuracy, should be welcomed.

W. J. Seeley, professor of electrical engineering, Duke University, has recently devised a method which does just that. He writes

$$\sqrt{a^2 + b^2} = b\sqrt{1 + (a/b)^2},$$

where a is the larger number, and then multiplies and divides the right-hand side of the equation by a/b, giving

$$\sqrt{a^2 + b^2} = \frac{a\sqrt{1 + (a/b)^2}}{a/b} = a\left[f(a/b) \right] = aK.$$

That is, the square root of the sum of the squares of the two numbers is simply the larger of the two numbers multiplied by a factor K, which is a function of the ratio (a/b). The ratio is always taken so as to be greater than unity. The factors K have been computed and tabulated for all values of the ratio from 1.000 to 2.999; from 3.00 to 9.99; and from 10 to 30 (by halves). Values of K for 40 and 50 are also included. Above this ratio the final value is very little different from the larger of the two numbers. This convenient and time saving little table of K factors may be obtained from The Engineers Publishing Co., 310 N. 11th Street, Philadelphia, for ten cents per copy.

DATES LICENSES GRANTED TO NEW YORK BROADCAST STATIONS

WJZ	Sept. 29, 1921
WOR	Feb. 18, 1922
WHN	Mar. 16, 1922
WGCP	Mar. 11, 1922
WAAM	Apr. 10, 1922
WEAF	Apr. 27, 1922
WQAO	Jan. 31, 1923
WSDA	Mar. 23, 1923
WNJ	June 15, 1923
WBBR	Jan. 31, 1924
WNYC	July 2, 1924
WEBJ	July 14, 1924
WPCH	July 16, 1924
WABC	Sept. 20, 1924
WGBS	Oct. 24, 1924
WGBB	Dec. 13, 1924
WBOQ	Mar. 26, 1925
WHAP	Mar. 26, 1925
WMCA	Mar. 28, 1925
WODA	Apr. 8, 1925
WIBI	May 7, 1925
WRNY	June 19, 1925
WIBS	June 29, 1925
WLWL	Aug. 10, 1925
WJBI	Aug. 21, 1925
WBNY	Sept. 2, 1925
WRST	Sept. 14, 1925
WFRL	Sept. 21, 1925
WMSG	July 15, 1926
WMRJ	July 16, 1926
WSOM	July 27, 1926
WWRL	Aug. 16, 1926
WAAT	Aug. 19, 1926
WBRJ	Aug. 19, 1926
WBBC	Aug. 24, 1926
WKBO	Sept. 11, 1926
WTRC	Sept. 25, 1926
WKBQ	Sept. 25, 1926
WBMJ	Oct. 20, 1926
WBKN	Nov. 2, 1926
WARS	Nov. 3, 1926
WCGU	Nov. 21, 1926
WDWM	Nov. 22, 1926
WLBH	Dec. 6, 1926
WTRL	Dec. 18, 1926
WLBX	Dec. 29, 1926
WMBQ	Jan. 28, 1927
WGL	Jan. 30, 1927

SOME OF THE PROBLEMS OF MOTOR CAR RADIO DESIGN

(*Concluded from page 17*)

ment, tubes must not be allowed too much vibration, the receiver must remain unaffected by its adverse operating conditions. To fulfill this requirement of extreme compactness, and rigidity often taxes ingenuity.

As an example of what may fairly be considered good design, a short description of a commercial motor car receiver is given here.

The circuit is shown in Fig. 1. A 78 tube is used in the r.f. amplifier and preselector circuit. A 6A7 pentagrid converter combines the functions of oscillator and of translator or first detector. A 78 tube is used in the i.f. stage and an 85 provides avc diode detection and audio amplification. Two type 41 tubes in push pull are capable of supplying 3½ watts to the dynamic loudspeaker. Thus, the six tubes fill functions that would require nine tubes were a separate mono-purpose tube used for each function.

A vibrator type of power supply with mechanical rectifier is used.

The total battery drain is only 5.75 amperes, not much more than that of a single headlight bulb.

The receiver has a gain of 130 db. made up as follows:

20 db. in the antenna stage.
35 db. in the r-f. stage.
35 db. in the translator.
35 db. in the i-f. stage.
5 db. in the audio stages.
——
130 lb. total.

The avc range is 60 db. That is, the signal strength can vary by a ratio of 1000 to one and the output of the receiver will not change by more than a two-to-one ratio. The band width is 12 kc. for a ten times signal and 19 kc. for a one hundred times signal. The power sensitivity curve is shown in Fig. 2.

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COMMON FREQUENCY BROADCASTING

(*Concluded from page 21*)

interference at listeners receivers. As soon as normal conditions are re-established, precise synchronization is restored promptly and automatically.

This common frequency broadcasting equipment makes it possible to operate a chain of widely distributed stations on a common frequency system without any special synchronizing link between the individual stations other than the circuit providing the reference frequency.

How Fast Do Radio Operators Send and Receive Code?

AT the radio amateur's convention, held in Chicago during the past summer, a code operator's speed contest was held in which the title passed to Mr. Joseph W. Chaplin, radio operator for Press Wireless, Inc., New York, who copying at a speed of 57.3 words per minute, qualified for first place by making only 11 errors out of an allowable 14. The nearest contender, T. R. Mc Elroy, formerly of the Western Union and Associated Press, qualified for second place by copying at a speed of 54.1 words per minute, with but 8 errors. At this speed Mr. Chaplin had but 5 errors.

It is of interest to record that there was a series of contests held by Morse wire telegraphers from the year 1868 until 1915. There have been preserved detail records and data of all of these contests. In the Morse contests the laurels usually went to the operators who could transmit by hand key (later by Vibroplex) the largest number of words straight matter in five minutes, the readability of the transmission being the criterion of accomplishment. In the radio contests the ability to copy from automatic transmission at high speed appears to be the objective. In view of modern methods of commercial traffic handling there is reason for this departure, but it is predicted in view of the defective code sending of many amateur and some commercial radio operators of the present time that future contests may include events based on accurate and rapid sending.

A cherished prize in the wire men's contests was the famous Carnegie diamond medal, last won at San Francisco in 1915 by Thomas R. Brickhouse, a "broker" telegrapher, now in New York. It may be that Mr. Brickhouse will be willing to turn this trophy over to the radio speedsters to scrap for annually, as the beautiful trophy at last accounts reposes in a safety deposit box in New York.

Reviewing the contests held by radio operators it is disclosed that the first contest was held by operators of the United Wireless Telegraph Company, at Philadelphia, February 23, 1910. Radio contestants were Robert F. Miller and David J. Heilig, of the United Wireless Co. A dozen or more of the other contestants were operators employed by the Postal Telegraph-Cable Co., and the Western Union Telegraph Co. The American Morse code was used in radio at that time. Miller won the prize cup, and Harvey Williams, of the Western Union won the runner up cup.

On November 28, 1920, at a Pacific Radio Convention held in San Francisco, A. E. Gerhard won first place by copying (Continental code) from Wheatstone transmission, 49¼ words per minute for four minutes, with but five errors. Gerhard was then employed at R. C. A.'s station at Marshall, Calif.

On March 18, 1921, at the Pennsylvania Hotel, New York, B. G. Seutter, of the *Times* radio staff, New York, won first place by copying from automatic transmission 48 3/5 words per minute, with 2 errors. Second place was awarded N. Bernstein, of the Western Union, who copied the same number of words but made 3 errors.

On March 10, 1922, at the Pennsylvania Hotel, New York, Jose M. Seron, of R. C. A., won first by copying 49½ words per minute, with 2 errors. On May 6, the same year at the Boston Radio Show, T. R. Mc Elroy, of the Boston *Herald*, wrested the championship from Mr. Seron by copying 51½ words per minute on a typewriter, copying for three minutes before making a mistake. Wheatstone transmission was employed. On May 24, the same year at a contest held in the 71st Regiment Armory, New York, Mr. Mc Elroy won first prize by copying 56½ words per minute. His opponents were B. G. Seutter and Joseph C. Smyth. At a Boston tournament, held in November, 1922, Mr. Smyth captured the honors by copying 55 words per minute, five errors. On this occasion Mr. Mc Elroy, at the same copying speed, made 6 errors. At Chicago, on August 6, 1922, Mr. Mc Elroy won the diamond medal by copying 52 1/5 words per minute, perfect copy. In an extra event at this contest Mr. Mc Elroy copied 55 1/10 words per minute, perfect copy. His May 24, New York, record was 56½ words per minute, four errors.

On March 7, 1924, at the Pennsylvania Hotel, New York. A. E. Gerhard of R. C. A., copied straight matter at a speed of 59½ words per minute. Just a year later Mr. Gerhard took first at an amateur show by copying 56.1 words per minute, no errors.

On March 11, 1926, Edward Adler, of R. C. A., at the Pennsylvania Hotel, New York, copied at the rate of 58 words per minute, 2 errors. R. C. Mc Pherson, R. C. A., won second with 58 words, 4 errors. Mr. Adler was then twenty-three years of age.

At an R. C. A. contest held in January, 1928, R. C. Mc Pherson copied 48 words per minute; A. C. Burnette, 60 words per minute slip reading, and R. C. Mc Pherson 65 words per minute perforating tape.

In contests of this kind where the difference of a word or two per minute is likely to make championships change hands, it is important that the radio telegraphers adopt a standard set of words to serve as matter to be transmitted in all future contests, as in former years Morse telegraphers adopted the famous "Command of Gideon" text.

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IS COMPETITION IN COMMUNICATION TO END?

(*Concluded from page* 18)

the aggressive aid of certain congressmen, to nationalize communication. The policies laid down and the plans inaugurated had all the ear marks of a determination to prevent a return of the companies to private ownership. On April 8, 1919 telegraph rates were increased 20 percent. On February 20, 1920, the radio stations were returned to their owners, the wire lines having been returned on August 1, 1919.

The war time operation of telegraph and telephones had for that brief period cost the taxpayers $14,418,237.

Socialistic tendencies and politics aside, unquestionably there are moves which might be made to strengthen the communication companies, one of which would be to do away with competitive services where these are not profitable to participating companies. On the other hand it is true that neither the public nor industry would put up with service inferior to that to which they have become accustomed.

A chronological history of electrical communication —telegraph, telephone and radio

◆

This history began with the January 1, 1932, issue of RADIO ENGINEERING. The items are numbered chronologically, beginning at 2000 B.C., and will be continued down to modern times. The history records important dates, discoveries, inventions, necrology and statistics, with numerous contemporary chronological tie-in references to events in associated scientific development. The material was compiled by Donald McNicol.

◆

Part XXV

1901 (*Continued*)

(993) J. J. Carty, New York, introduces bridging bells in telephone operation.

(994) Marconi, at St. Johns, Newfoundland, receives a wireless telegraph signal in the form of repetitions of the letter "s" from the Marconi station at Poldhu, Cornwall, England, December 12.

(995) Elisha Gray dies. (Born in United States 1835.)

(996) Z. T. Gramme dies. (Born in Belgium 1826.)

(997) A generator of 1 kw. capacity, at 10,000 cycles, is built in the United States for wireless signaling purposes.

(998) Marconi invents the magnetic detector, for the detection of wireless signals.

(999) An electrical system of steering steamships is invented by Platischer.

(1000) Electricity replaces steam power on New York elevated railway lines. (Steam locomotives had been used since the year 1872.)

(1001) Charles F. Scott is elected president of the A.I.E.E.

(1002) Lee de Forest, in Chicago, develops a system of wireless telegraphy.

(1003) The auto-dot, or wig-wag Morse transmitter introduced in telegraph operation in the United States and Canada.

(1004) Robert C. Clowry succeeds T. T. Eckert as president of the Western Union Telegraph Company.

(1005) John C. Barclay, of New York; Jay R. Page, of Chicago; W. R. Phelps, of Philadelphia, and George B. Scott develop jointly an improved stock ticker system embodying the best features of existing systems.

(1006) S. F. B. Morse's estate with a gross value of $524,000.00 is settled by the Supreme Court. Morse's orders and decorations are turned over to the National Museum at Washington. (Mrs. Morse died in Berlin, Germany, November 14, 1901.)

(1007) The British Pacific submarine cable from Vancouver, B. C., to Australia, completed October 31, and is opened for public service December 7.

(1008) A submarine telegraph cable is laid by the war department between Juneau and Sitka, Alaska. Completed October 2.

(1009) M. I. Pupin, New York, procures American patents numbers 707,007 and 707,008 covering a system of multiple telegraphy.

(1010) A. C. Crehore procures American patents numbers 707,829, 707,830 and 707,959 covering the invention of systems of telegraphy.

(1011) G. M. S. Angelo, of Italy, procures an American patent, No. 707,612, for the invention of a system of printing telegraphy.

(1012) The wireless telegraph system invented by M. Rochefort, in France, is given a trial by the United States navy department.

(1013) The Safety Insulated Wire and Cable Company, of Perth Amboy, N. J., makes a six hundred-mile length of submarine cable for the Mexican government.

1902 (1014) R. A. Fessenden procures U. S. patent No. 706,737 for a system of radio signaling employing long waves (low frequency).

(1015) The Belden Manufacturing Company, makers of wire, organized in Chicago.

(1016) Mr. Marconi, in February, on board the *S. S. Philadelphia*, receives wireless signals over a distance of 1,551 miles.

(1017) An Anglo-French telephone cable is laid between St. Margarets and La Panne, April. The cable contains two circuits, one of which is superposed for telegraph working.

(1018) The Printing Telegraph Company is organized in New Jersey, by Henry G. Stephens, Benjamin Rosenthal and Herman Lewis.

(1019) C. C. Duvall and E. W. Campbell install on telegraph lines of the American Tin Plate Company, a system of simultaneous telegraphy and telephony, similar to Van Rysselberghe's method.

(1020) National Electric Signaling Company organized in New Jersey with a capital of $100,000.

(1021) The American Telephone and Telegraph Company, through its subsidiary companies, operates 1,952,412 telephone stations. Independent telephone companies in the United States operate 700,000 telephone stations.

(1022) Charles E. Yetman, of Ilion, N. Y., procures patent No. 692,967 for a combination typewriter and telegraph transmitter.

(1023) For the year ending December 31, 1901, the gross earnings of the Commercial Cable Company were $3,371,063, and the net $2,259,897.

(1024) A fast-sending telegraphers' tournament is held at Atlanta, Ga., March 1.

(1025) Emperor William, of Germany, issues an order giving the Slaby-Arco system of wireless telegraphy exclusive rights in Germany.

(1026) Ten different railroad systems now use Edison's Phonoplex system of induction telegraphy.

(1027) Lord Kelvin pays a visit to the United States.

(1028) The offices of the American Institute of Electrical Engineers are moved from the Havemeyer Building, Dey and Church Streets, to No. 95 Liberty St., New York.

(1029) Stephen D. Field returns from Geneva, Switzerland, where for some years he has been stationed directing electric railway installation in Europe.

(1030) A. E. Kennelly is appointed professor of electrical engineering at Harvard University.

(1031) P. O. Pedersen, of Copenhagen, Denmark, secures an American patent covering the invention of the Telegraphone.

(1032) Bernard A. Behrend, in the United States, develops turbo-generators with cylindrical cores and radial slots.

(*To be continued*)

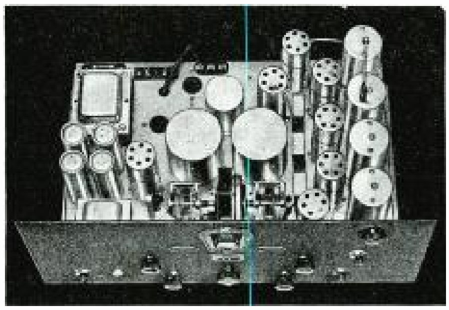
HAMMARLUND

COMET "PRO"

HIGH FREQUENCY SUPERHETERODYNES

for use in

BROADCAST STATIONS, POLICE RADIO, AIR-MARINE WORK, etc.



Now adapted for

AUTOMATIC VOLUME CONTROL AND CRYSTAL FILTER

Now four models of this world-famous, complete 15 to 250 meter receiver:—STANDARD—STANDARD, with A.V.C.—CRYSTAL—CRYSTAL, with A.V.C. Operating on Battery, D.C. or A.C. in all voltages and cycles. Extra coils for 8-16 or 250-550 bands, $5 per pair. Crystal Filter and A.V.C. may be added, at moderate cost, to Standard model. Write Dept. RE-1 for details.

Some COMET "PRO" users are:

War Department, Washington, D. C.
Naval Research Laboratory
Canadian National Defense
Swedish Bureau of Telegraph
British Air Ministry
American Airways
Eastern Air Transport
National Broadcasting Company
Columbia Broadcasting System
Bell Laboratories
International Telephone and Telegraph
Byrd and Other Expeditions
Prominent Universities
News Services
Shipping and Other Commercial Agencies
Throughout the World.

Without obligation a sixteen page booklet giving complete technical details and performance data will be forwarded upon request.

For Better Radio
Hammarlund
PRECISION
PRODUCTS

HAMMARLUND MFG. COMPANY

424 W. 33rd Street,
New York, N. Y.

For 1934 Auto-radio

ASSURE TROUBLE-PROOF POWER SUPPLY

Pioneer Gen-E-Motors

offer these advantages

- ***Lifetime Trouble-Free Service.***
  Leading auto-radio set builders have found that freedom from failure and costly replacements makes a Pioneer Gen-E-Motor the lowest cost power supply.
- ***No Adjustments or Lubrication.***
  Pioneer Gen-E-Motors have frictionless, wear-free ball bearings with sealed-in lubricant sufficient for life. No further lubrication or adjustments are required in service.
- ***Better D.C. Output with Less Filter.***
  The Pioneer Gen-E-Motor supplies an output voltage requiring far less filter expense. The final filtered voltage output has less than 150 millivolts fluctuation, assuring superior receiver audio output.
- ***Small Size Facilitates Set Design.***
  The Pioneer Gen-E-Motor occupies the same or less space than that needed for other types of power supply and may be easily substituted in your chassis.

Write or wire for test sample and full details of the power supply that will make your auto-radio the choice of experienced dealers.

Pioneer 32 Volt and 110 Volt Power Units

The complete Pioneer Gen-E-Motor Line includes 32 volt D.C. to 225 volt D.C. units for plate power of 32 volts D.C. farm receivers; high voltage supplies for power amplifiers; 32 volt D.C. to 110 volts A.C. and 110 volts D.C. to 110 volts A.C. converters. Write for full information on any power supply need.

PIONEER GEN-E-MOTOR CORP.

1162 Chatham Ct. Chicago, U. S. A.

METAL NAME PLATES

L. F. Grammes and Sons, Allentown. Penna., announce a complete line of metal name plates, clock dials, battery connectors and various other items of metal stampings and wire formings. The company has issued a new illustrated catalogue copies of which will be forwarded upon request.

◆

EXPRESS COMPANY PREPARES FOR INCREASED SHIPPING IN 1934

After a survey of economic conditions in different sections of the country, officers of the Railway Express Agency recently decided that the trend is upward and are now preparing for increased shipping in 1934.

In fact, L. O. Head, president of the express company, has inaugurated a business-building campaign which he has termed "A New Deal in Express Business" and has undertaken a rapid tour of large cities in the East, Middle West. Southwest and South, to enlist local express employees in a cooperative effort to stimulate shipping and aid in business recovery.

Special attention is being paid to furthering the use of express in basic manufacturing and distributing industries, in which this type of expedited transportation, providing through service from door to door, has proved to be especially useful in the past.

◆

AIR-CELL RECEIVERS

With further improvement in dry primary batteries a new impetus has been given to the sale of battery operated radio receivers. Manufacturers are meeting the demand by adapting their battery operated sets to the new batteries. The National Carbon Company's air-cell A battery is being widely adopted for this use. On a one-half ampere load this cell is said to give a full 1200 hours service.

◆

BRONZE, NICKEL AND COPPER

The Riverside Metal Company, Riverside, N. J., has issued a new booklet describing the company's phosphor bronze, nickel silver and Beryllium copper products. Copies of this informative publication may be procured by writing to the Riverside Metal Company.

◆

INSTITUTE CONVENTION

Plans are being completed for the second annual regional convention of the Institute of Radio Service Men to be held at the Hotel Sherman in Chicago. February 23, 24, and 25, 1934. Continued insistence from various sources has caused the general office of the Institute to make an experiment to include a Sunday in the three-day meeting on the theory that it will enable more of the service men to attend without loss of time from their work.

LITTELFUSE MOVES

The Littelfuse Laboratories, manufacturers of electric protective devices, have moved to larger quarters due to the increased volume of business. Various new types of fuses have been recently added to the Littelfuse line including an aircraft anti-vibration type and the "lo-loss" low resistance automotive type designed for use in auto radios of the synchronous vibrator type. The new Littelfuse factory is located at 4507 Ravenswood Ave., Chicago, Ill.

Catalogs and literature may be obtained by communicating with the Littelfuse Laboratories at their new address.

◆

PRECISION CRYSTALS AND H-F. COILS

The Premier Crystal Laboratories, Inc., 53-63 Park Row, New York, have issued a bulletin describing precision crystals, holders for same, and adapters. The Laboratories also announce a line of high-frequency coils, range from 6 to 60 megacycles, with plug-in mounting. These are made up in 1, 2, 3 and 5 turn units of copper tubing.

◆

FARNSWORTH TELEVISION TRANSMITTERS TO BE MADE BY HEINTZ & KAUFMAN

Television Laboratories, Ltd., of San Francisco and Philadelphia, have licensed Heintz & Kaufman, radio manufacturers at San Francisco, to construct television transmitting equipment under the Farnsworth patents for television by aid of cathode-ray tubes. License for the manufacture of receiving equipment has already been granted to an eastern radio manufacturer in whose laboratories Farnsworth spent two years in perfecting his receiver for commercial use.

Television Laboratories, Ltd., is planning a vigorous campaign for television service to all important centers of population in the United States before the end of 1934. Philo T. Farnsworth has assigned to them nearly a hundred patents which cover every detail in the successful reproduction of motion pictures by radio, including direct pickup at the scene of action. These pictures are now being transmitted over wide channels in the neighborhood of 5 meters. The received images are reproduced as a brilliant black-and-white motion picture and contain 90.-000 elements (300-line) repeated at the rate of 24 pictures per second. The pictures and accompanying sound effects are transmitted on the same wavelength and roproduced from the same cabinet.

◆

NEW ELECTROLYTIC CATALOG

The Curtis Condenser Corporation of 3601 West 140th Street, Cleveland, Ohio, has just published a new 1934 catalog of dry electro-chemical condensers.

With the addition of many new types and sizes, the Curtis line has become one of the most complete now offered to radio manufacturers and servicemen.

PRESSLEY BECOMES CHIEF ENGINEER

J. H. Pressley, for many years an outstanding engineer identified with radio invention and development. has been appointed chief engineer of the Zenith Radio Corporation. Chicago, Ill.

◆

GRAPHITE ANODE 205D TUBE

Having succeeded in adapting the graphphite anode to the 205D type (see RADIO ENGINEERING, August, 1933), the Hygrade Sylvania Corporation of Clifton, N. J., now announces a refined tube whose mechanical and electrical characteristics are outstanding.

The graphite anode, which is not only a getter but also a keeper, makes this tube sturdier, freer from gas and capable of dissipating more power than has hitherto been obtained. Because of its greater dissipating power, the grid inside the anode is operated at cooler temperatures, reducing the possibility of gas from this element. Also with the new construction longer insulation paths are provided, which reduces the possibility of leakage between elements.

◆

ZIERICK MOVES

The F. R. Zierick Mfg. Co., manufacturers of Automatic Metal Stampings, announce the removal of their office and plant to the Bronx Lehigh Bldg., 385 Gerard Ave.. New York, N. Y.

They not only make the dies and tools for fabricating their stampings, but do hot tinning. nickel plating, and cadimium plating under one roof.

◆

H-F. SUPERHETERODYNE RECEIVER

For code or voice reception in the frequency range from 20,000 to 1,200 kc. the Comet "Pro" receiver being marketed by the Hammarlund Manufacturing Company, Inc., 424-438 West 33d St., New York, has several novel features.

An important feature of the Comet "Pro" is the intermediate oscillator, which can be started and stopped by the toggle switch on the panel. It consists of a "58" tube and associated circuits permanently adjusted to oscillate at the intermediate frequency of 465 kc. Like the high-frequency oscillator, it is also of the "electronic coupled" type. This results in great stability of oscillation and entirely eliminates the "pulling into step" effect when receiving strong cw. signals.

The "Pro" is also available with an automatic gain control circuit which can be cut in or out by means of a switch on the front panel. As in the case of the "Crystal Pro" this model operates exactly as a "Standard Pro" when the avc switch is in the "off" position.

Due to the high sensitivity of the "Pro," a wide range of control voltage is required to secure complete regulation of the i-f. gain without affecting receiver performance on extremely weak signals. A 2B7 is used as a separate avc tube.

Insure Speed, Safe Delivery and Dependability by Shipping Your Goods by RAILWAY EXPRESS

Here is a way to eliminate all the guesswork in the handling of your merchandise—whether you are the shipper or receiver—and at the same time eliminate the round of time-wasting troubles on lost and delayed shipments when handled through two or three miscellaneous shipping companies.

Specify Railway Express on *all* your shipments and then you will be sure that your orders will be delivered safely and quickly either to you or to your customer.

Railway Express is a single responsible organization with nation-wide coordination and team work that makes Rush a *reality* and not just a meaningless word.

Futhermore, through prompt Railway Express service you will be able to keep lines of quick-moving merchandise filled by daily delivery and thus not miss a single sale. Shipping costs by Railway Express are moderate and include liability up to $50 on packages not exceeding 100 lbs. We give a receipt to the shipper and take one from the consignee—double-barreled proof of safe collection and delivery. A telephone call brings the Expressman to your door at all places where vehicle service is maintained.

SERVING THE NATION FOR 94 YEARS

RAILWAY EXPRESS AGENCY

NATION-WIDE SERVICE

Weston Capacity Meter Model 664

AN *Accurate* INDICATOR OF CAPACITY VALUES

Here is another accurate indicator of radio's fundamentals — one of a complete line bearing the name Weston. To the dealer and service man this means that the instrument is the "last word" in test equipment . . . that it will prove a dependable and profitable partner in his business.

Like other Weston instruments Model 664 will not become obsolete because of its wide ranges and because it indicates in fundamental units — microfarads and volts. It can be furnished in a leatherette covered carrying case, or will fit into the Weston Standardized Service Kits along with other Weston standardized service units. All the facts are included in the Weston bulletin. Send for your copy. Use the coupon today. Weston Electrical Instrument Corporation, 612 Frelinghuysen Avenue, Newark, N. J.

WESTON Radio Instruments

WESTON ELECTRICAL INSTRUMENT CORPORATION
612 Frelinghuysen Avenue, Newark, N. J.

Send Bulletin on Weston Radio Instruments.

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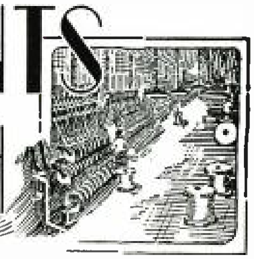
NEW DEVELOPMENTS OF THE MONTH



NEW 831A TYPE TUBE WITH TUNGSTEN FILAMENT AND FLOATING ANODE

Under the 831A type designation, the Hygrade Sylvania Corporation, Clifton, N. J., announces a new type 830 oscillator, amplifier and modulator tube. The new type is provided with a pure tungsten filament in place of the usual thoriated tungsten. More than ample emission is retained while gaining the positive and long-life characteristics of the pure tungsten emitter. The floating anode feature means that the anode is suspended on lava collars to eliminate corona effect, especially when employed in ultra-high-frequency circuits. As with other Sylvania transmitting, power and large rectifier tubes, type 831A is provided with a one-piece pure graphite anode.

◆

A STURDY RESISTANCE UNIT

Hardwick, Hindle, Inc., Newark, N. J., have brought out a new resistor unit mounted in punched steel casing. The strip resistor is wound on a pure mica form which is imbedded in vitreous enamel. The winding is non-inductive and can be furnished with any number of intermediate taps. There are four standard sizes, 25 to 60 watts. Mounting may be vertical or horizontal.

◆

MICROPHONES

The Astatic Microphone Laboratory, Inc., Youngstown, Ohio, announces a new line of microphones which have several unique features. The exterior of the instrument is made of strong, durable metal, the microphone proper being suspended on the inside, protecting it. The unit is housed in a chromium plated case three inches in diameter and one inch thick. The connection is by means of a six-inch shielded cable.

◆

CANDOHMETER RESISTANCE INDICATOR

The Muter Candohmeter is an accurate, uniform, wire-wound resistor insulated from and enclosed within a metal housing with a narrow slot on top permitting contact with the resistor at any desired point. A contactor or test prod, mounted in an insulated handle, is furnished with each

Candohmeter. The Candohmeter is invaluable to the radio service man or experimenter for the following purposes:

To determine the proper resistance to replace a defective resistor.

As a voltmeter multiplier, enabling measurement of high voltages with a low range voltmeter.

As a calibrated resistor for use in experimental work.

Manufactured by the Muter Company. 1255 So. Michigan Ave., Chicago, Ill.

REMOTE CONTROL AMPLIFIER

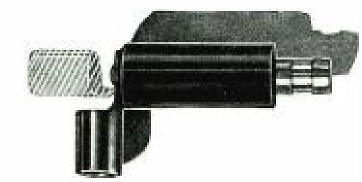
The Gates Radio & Supply Company, Quincy, Ill., have released bulletin 8B to broadcast stations, describing their new type B-96 portable remote control amplifier for use where wide-range service is required. This amplifier is featured by its complete calibration, in decibels, including the mixer circuit, master gain and volume indicator. It has four audio stages, developing a satisfactory gain for practical use with nearly all types of microphones.

Bulletin 8B will be sent to those desiring it upon request.

◆

CONTINENTAL ADDS BAKELITE SUPPRESSORS

A complete new line of molded bakelite suppressors is now offered by Continental Carbon, Inc., of Cleveland, Ohio. In addition to all standard terminal designs, Continental has a new flexo-terminal universal suppressor with a spring bronze spark-plug connector that may be bent to allow easy installation on any motor. Thus, a receiver shipped from the factory with



flexo-terminal suppressors may be installed on any car without the dealer having to exchange or stock any special suppressor types.

◆

NEW MELTING AND SOLDER POT

The Newton Junior Corporation, New Haven, Conn., announces a new melting and solder pot for factory and general use.

It is made of special cast iron, is wound with a high grade heating element and is insulated with Pourinsul, one of the most efficient insulations known. It will melt continuously as metal is used and new metal added or it can be used to melt waxes or other similar substances frequently used in manufacturing processes.

◆

"A" PACK FOR USE WITH 2-V. TUBE BATTERY OPERATED SETS

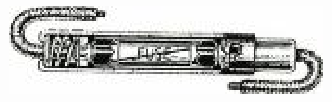
Burgess Battery Company, Freeport, Illinois, announce the No. 1040 "A" battery especially designed for 2-volt tube radio receivers. This new "A" pack embodies a "close pak" construction which makes it light, portable, and economical.

Will give 400 hours service at a cost of less than 1c per hour. Weight—15 pounds; size 12 9/16 inches x 4½ inches x 6 13/16 inches. Easy to handle, attractive in appearance. No servicing with water or chemicals. 100 per cent DRY; hermetically sealed.

FUSE RETAINER FOR AUTO RADIO

A new product announced by the Littlefuse Laboratories, 1772 Wilson Avenue, Chicago, Ill., is their No. 1070 fuse retainer and antenna coupler. The retainer takes the regular 3AG automotive fuse and hangs directly in the hot line leading to the radio receiver.

It takes auto cable up to 5/32 inch diameter, and the shielding, where neces-



sary, can be attached to the retainer. Fuse renewals are made by turning the small bayonet lock.

When used as an antenna connector, the fuse is omitted, and the contact buttons are placed directly together, instead of at the fuse ends. Contact is maintained by a strong spring pressure.

◆

QUICK-ACTING 25Z5

One of the outstanding tube developments of the year is the new quick-acting Arcturus 25Z5 rectifier which operates in 17 seconds, announced by the Arcturus Radio Tube Company, Newark, N. J. Many of this year's sets, particularly the a-c.—d-c. models, use the 25Z5 as well as the 43, both indirectly heated tubes which have required 60 seconds or longer to operate.

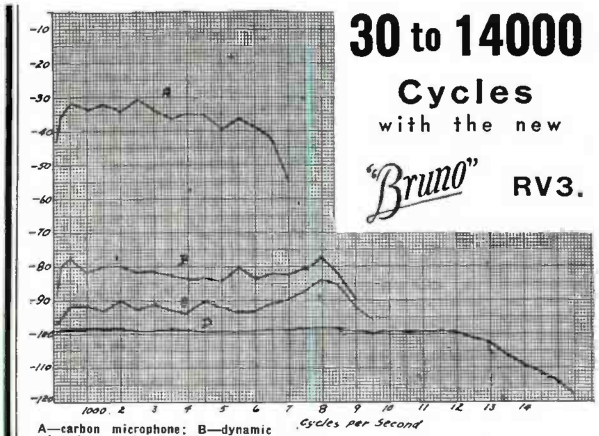
The new Arcturus 25Z5, as well as the Arcturus 43, which also is a quick-heater, enables these sets to operate in 17 seconds or one-third the time formerly required.

Laboratory and field tests have further proved that this quick-action extends the life of other tubes in the series-operated a-c.—d-c. receivers as well as protects the filter condenser. The quick-heating feature permits the tube to reach the value of hot or high filament resistance in a shorter time and thereby eliminates the excessive over-voltage on other tubes usually caused by slow-heating, low resistance tubes.

◆

UNIVERSAL TEST INSTRUMENTS

Three units for testing, locating and determining cause of trouble in radio receivers, audio amplifiers and any type of apparatus which employs conventional vacuum tubes have been designed by the Sound Engineering Corporation, 416 N. Leavitt Street, Chicago, Illinois, to comprise a service instrument of extreme versatility. Each unit is a complete self-contained and highly useful instrument in itself and all combine to form the very latest thing in analytical test sets. Each unit has been carefully designed and engineered to provide the maximum of utility with simplicity both as to operation and construction.



30 to 14000 Cycles

with the new "Bruno" RV3.

A—carbon microphone; B—dynamic microphone; C—condenser microphone; D—velocity microphone.

Your audience demands true fidelity—clear cut tones—sparkling notes.

Hold your listener's attention by answering this demand with the

BRUNO RV3

VELOCITY MICROPHONE

1—Excellent fidelity characteristics
2—Frequency response 30 to 14000 C.P.S.
3—Not subject to variations with humidity and temperature
4—No diaphragm
5—Highly directional
6—Reduces acoustic feed back
7—Affords higher gain
8—Ruggedly constructed

Price in U. S. A. $55.00.

BRUNO LABORATORIES Pat. Pending

20-26 WEST 22nd STREET NEW YORK CITY

ELMET

MOLYBDENUM

FOR

GRID WIRES

SUPPORT WIRES

ELECTRIC FURNACE HEATING ELEMENTS

ALSO FOR

SCREEN GRIDS--CATHODE COILS MANDRELS--CONTACTS, ETC.

ALL OF THE ABOVE PRODUCTS MAY BE HAD IN VARIOUS COMPOUNDS OF

MOLYBDENUM-TUNGSTEN

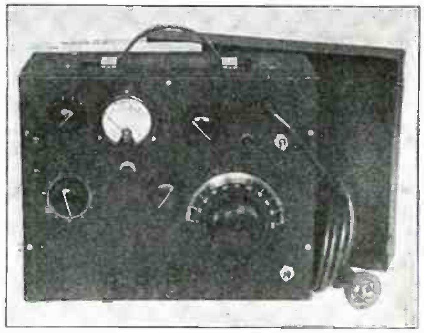
Write for Information and Prices

American Electro Metal Corp.

Lewiston Maine

Read what this Signal Generator does and judge for yourself.

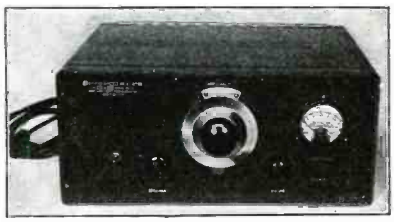
Believe it or not — it's true



The Model 310 Signal Generator incorporates every possible need necessary in set testing work. It attenuates down to ½ of 1 microvolt, it is entirely A.C. operated, has a frequency range of 100 to 1500 k.c. Has measured modulation up to 100% with 6% distortion, at 80% modulation distortion is 2.5%. Also it has provision for external modulation, supplies a pure 1000 cycle note for bridge measurements and a variable measured 1000 cycle note with measured attenuation and ideally suitable as a source for checking the gain of audio amplifiers. All of this is inclosed in a small shielded container measuring 10" x 12" x 5½" deep. Write for complete data describing this new instrument.

Price $95.00

MODEL 305 BEAT FREQUENCY OSCILLATOR



The Model 305 Beat Frequency Oscillator has found its way into the largest radio organizations in the country. Compact, neat, a handsome instrument for show in the laboratory—it can quickly be converted into a most handy and rugged unit for portable work. This of course due to its being supplied with a waterproof canvas covered carry case. Can be supplied for battery or for complete A.C. 60 v. operation. Is entirely self-contained, has a straight line logarithmic frequency curve, has a check point at 60 cycles visible in the output meter.

Price A.C. operated $155.00

NOTE

Our instruments are flexible in many ways. If our exact specifications do not suit, write us what your exact problems are. Frequency and attenuation ranges can be changed with ease.

WIRELESS EGERT ENGINEERING INC.

179 VARICK ST. NEW YORK CITY

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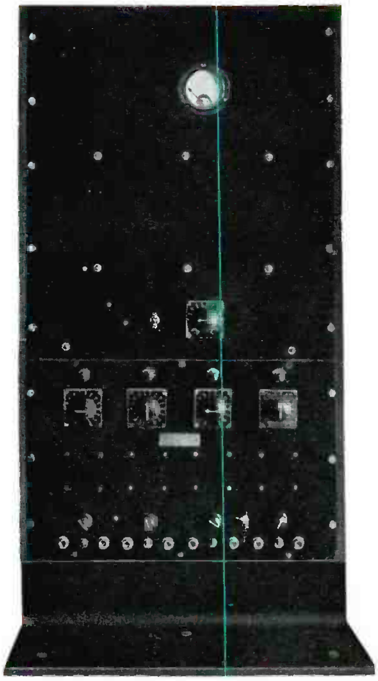
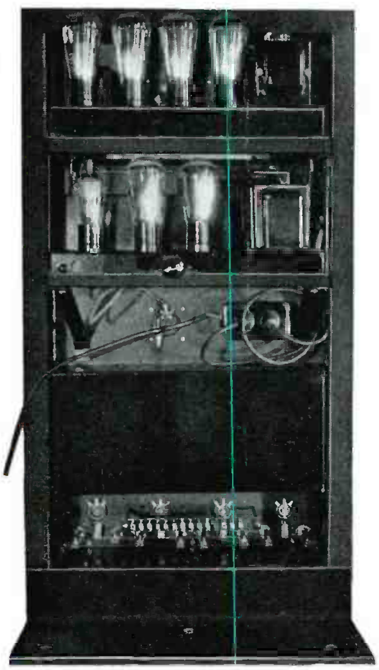


Front View
Gates Model PA-14 Amplifier



Rear View
Gates PA-14 Amplifier

GATES TYPE PA-14 AMPLIFIER FOR SOUND DISTRIBUTION AND PUBLIC ADDRESS SERVICE—

With 4 Channel Mixer and Volume Indicator

THE Type PA-14 affords complete high powered amplification for Public Address Service or Centralized Radio.

It is the very latest development in modern engineering and will meet the average requirements for high quality sound service in Public Address, Centralized Radio or Sound Trucks, and is priced very moderately.

It has a four channel constant impedance mixer, three stages of amplification, and volume indicator built into a compact rack 38 inches high, 20 inches wide.

For Centralized Radio a 72-inch rack is furnished to accommodate a radio receiver and control panel.

Output . . . . 32 Watts
Output Impedance 2, 4, 8, 16 and 500 Ohms
Input Impedance 200 Ohms Per Mixer Channel
A. C. Watts Consumption at 110 volt
60 cycle 225

Full technical description of Type PA-14 will be found on Pages 8 and 9 of Gates Catalog G-33. Why not write our Engineering Department today?

Designed and built by

GATES RADIO & SUPPLY CO.

Manufacturing Engineers

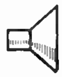
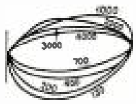
QUINCY, ILLINOIS

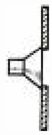
Gates Built Equipment • TRIED • TESTED • APPROVED

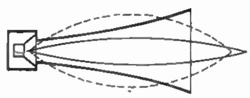
The World Over Since 1922

It Is Really Very Simple!

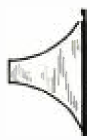
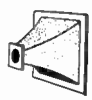
. . . YET SO FEW UNDERSTAND

IF YOU SUPPLY AUDIO FREQUENCY ENERGY TO A DYNAMIC CONE SPEAKER  THE CONE WILL VIBRATE AND PROJECT SOUND WAVES SHAPED LIKE THIS  . . . BROAD WAVES AT LOW FREQUENCIES—NARROW WAVES AT HIGH FREQUENCIES.

IF YOU MOUNT THIS SPEAKER ON A FLAT BAFFLE BOARD, THUS  THE SOUND WAVES OF ALL FREQUENCIES ARE FREE TO EXPAND TO THEIR NATURAL UNDISTORTED WAVELENGTHS. BUT THERE CAN BE NO FORCEFUL FORWARD PROJECTION BECAUSE THE SPEAKER VIBRATES ONLY THE SMALL VOLUME OF FREE AIR CONTAINED WITHIN THE CONE. IT IS LIKE WATER FROM A HOSE WITHOUT A NOZZLE,  JUST A PRESSURELESS STREAM.

IF YOU MOUNT THE SPEAKER IN A LONG HORN LIKE THIS  YOU "SQUASH" THE WAVE FORM AT LOW FREQUENCIES. THE VIBRATIONS SURGE FORWARD BUT THE LOWER FREQUENCIES ARE GREATLY DISTORTED. THE "BASS" RESPONSE IS IMAGINARY, ACTUALLY IT IS HORN RESONANCE.

SO WHAT?—YOU ASK. HERE IS THE SIMPLE SOLUTION!

THE PROJECTOR DEVICE MUST HAVE A PROPERLY DESIGNED WIDE, OUTWARD FLARE, BROAD ENOUGH  TO ALLOW FULL EXPANSION OF THE LOWEST FREQUENCY TO THE CUT-OFF. IT MUST BE DEEP ENOUGH TO PLACE AGAINST THE CONE A SUBSTANTIAL COLUMN OF AIR  — AN ADEQUATE LOAD — MOLDED EXACTLY TO THE CONE CIRCUMFERENCE. YOU THEN PROVIDE AN ACOUSTIC NOZZLE THRU WHICH ALL VIBRATIONS SURGE FORWARD TO THE OPEN AIR.

RACON ELECTRIC COMPANY, Inc., as the largest independent manufacturer of acoustic projectors, pioneered and has consistently advocated the wide-flared baffle. The largest and most experienced sound equipment companies use RACON wide-flared baffles for wide-range reproducing systems. A data sheet is available showing the many types and sizes obtainable. Write Dept. RE 1. Specific problems gladly considered.

RACON ELECTRIC CO. INC. 52 EAST 19th STREET, NEW YORK CITY
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