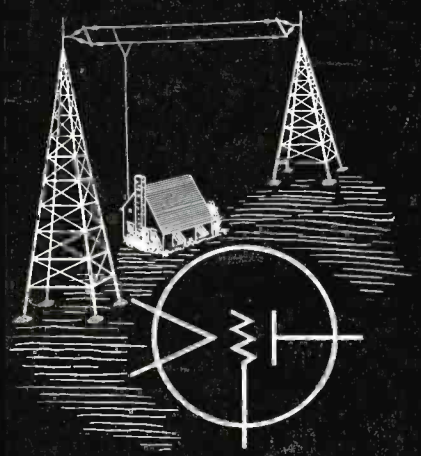
JUNE, 1932

# Radio Engineering



IN THIS ISSUE



TWELFTH YEAR OF SERVICE

The Journal of the Radio and Allied Industries

Characteristics of the
Wunderlich Tube

by

Frederick E. Terman, Sc.D.
Professor of Communication Engineering
Stanford University

"The Wunderlich tube can be thought of as a triode to which there has been added a second grid that is wound between the meshes of the usual grid. This tube has been developed for grid leak power detection purposes, and gives full wave grid rectification in a balanced circuit in which negligible radio frequency current flows in the plate circuit."

"When compared with the triode type of grid leak power detector, the Wunderlich power detector has about the same efficiency, introduces less distortion because the balanced input circuit prevents simultaneous grid and plate rectification, and develops approximately twice as much output voltage."

"When compared with the plate rectifier commonly employed in broadcast receivers, the Wunderlich detector has the advantage of a somewhat greater rectification efficiency, particularly when the signal voltage is in the order of several volts."

"The Wunderlich tube has ample power capacity to excite the power amplifier of any broadcast receiver now on the market, and also supplies a voltage which can be used directly for automatic volume control purposes."

*Excerpt from technical paper by Prof. F. E. Terman. Complete paper will be sent upon request.*

# WUNDERLICH

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*manufactured by* ARCTURUS RADIO TUBE CO., NEWARK, N.J.

# From "RADIO HEADQUARTERS"

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The RCA Victor line of speakers now includes the new RL-46 shown above. This new speaker is characterized by its rugged dishpan cone support and welded field structure, insuring permanence of its unusual tone quality. The cone of this speaker has been designed to handle powers up to 10 watts without overloading.

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Vol. XII | JUNE, 1932 | Number 6


## Contents



## Departments



### THE DAYS AHEAD

THE radio industry is betting $200,000,000 that American business will improve during the next 12 months, J. Clarke Coit, Chicago, president of the Radio Manufacturers' Association stated on the eve of the opening of the eighth annual convention and trade show of the association.

Much of this money has already been wagered by the manufacturers in expenditures on new machinery, new dies, re-tooling and other items required for changes in product and the balance will be spent during the next few months in purchases of stocks of raw material, labor hire and advertising, Mr. Coit declared.

"The radio industry has suffered during the past three years along with business in general," he asserted. "Radio has taken a lot of punishment, but the industry as a whole has weathered the storm quite well, and refuses to be disheartened.

"We take the attitude that business in general is just three years nearer a return to profitable operation than it was at this date in 1929.

"Just how soon business will start on the upgrade no one can say but some of us feel that a slow recovery is now under way. In any event our industry is betting $200,000,000 that conditions will be much better during the next 12 months.

"There are some 16,000,000 radio sets in operation in homes and a great many of them are obsolete. We therefore look forward to a good volume of replacements. Also, we must consider the fact that there are approximately 13,500,000 homes in the United States that are not equipped with radios."


BRYAN S. DAVIS
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**Bryan Davis Publishing Co., Inc.**
**19 East 47th Street**
**New York City**

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Chicago Office—333 N. Michigan Ave.—Charles H. Farrell, Mgr.
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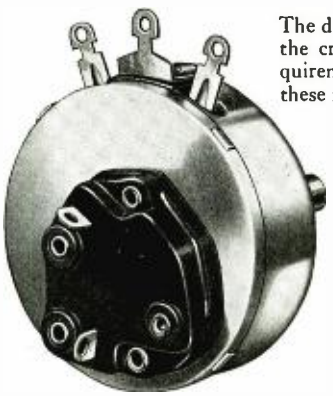
Los Angeles Office—846 S. Broadway—R. J. Birch
New Zealand—Tearo Book Depot—Wellington.
Melbourne, Australia—McGill's Agency.

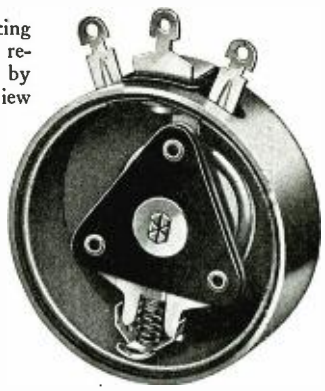
Entered as second class matter August 26, 1931, at the Post Office at New York, N. Y., under Act of March 3, 1879. Yearly subscription rate $2.00 in United States. $3.00 in Canada and foreign countries.

# Introducing the new Nos. 90 and 95 Series Heavy Duty Units, available with or without "H" or "T" Type Snap Switches



*No. 90 Series with Type T S. P. S. T. Low Torque Switch*

The demand for heavy duty units capable of meeting the critical resistance gradients and heavy load requirements of today's receiving sets is fully met by these new volume and tone controls. An exterior view of the new No. 90 is shown at the left. The right-hand illustration shows the interior construction of our No. 95 Series. These units are made with insulated or grounded shafts, as desired. In their construction the same type of double wiping contact is used that has proved so completely successful in our No. 20 Series. This contact method insures quiet operation by permanently maintaining clean, bright contacting surfaces. These new units may be obtained without switch, or with choice of our Type T or Type H Switches incorporated. A tap on the resistance element at practically any position also may be obtained.



*No. 95 Series, interior view, showing double wiping contact*

## No. 90 Series Units

Equipped with a combination wire-wound and composition resistance element, the No. 90 Series is ideal for use as a tone control across the plates of a pair of 47's, for the hazard of resistance element burning out at high output levels is effectively eliminated. Shaft is insulated to withstand 2.000 volts. If grounded shaft is desired, specify No. 91 Control.

## No. 95 Series Units

We can furnish the new No. 95 in materially higher resistance values than have heretofore been available in wire-wound radio control units. These resistance elements can be supplied in single or multi-section windings. Insulated shaft will withstand in excess of 2,000 volts. For grounded shaft unit specify No. 96 Control.

**CHICAGO TELEPHONE SUPPLY CO. OFFERS RADIO'S MOST COMPREHENSIVE LINE OF VOLUME AND TONE CONTROLS**

*No. 11 Snap Switch*

## New No. 11 Snap Switch

Has lowest operating torque of any commercial switch, smallest knob movement, and extremely low and uniform contact resistance. Positive kickoff. Double bearing "cold" cam cannot bind or wabble in operation. Electrostatic shield prevents hum pickup by volume control from live parts of switch. Supplied in S. P. S. T. type for panel mounting or in combination with our various types of volume and tone controls. Approved by Underwriters' Laboratories for 3A., 125 v., 1.5 A., 250 v., AC or DC.


*No. H Switch, for panel mounting, D. P. S. T. or S. P. D. T.*

*No. H interior view*

## No. H Snap Switch

Like our No. 11, the No. H Snap Switch has low operating torque and low, uniform contact resistance. Supplied for panel mounting, as illustrated at left, or in combination with our various types of volume and tone controls. Made in D. P. S. T. or S. P. D. T. types. Bakelite housing; silver-plated contacts, with wide separation of all live parts from the cam. Approved by Underwriters' Laboratories for 3A., 125v., 1.5 A., 250v., AC or DC.

# CHICAGO TELEPHONE SUPPLY CO.

HERBERT H. FROST, Inc. / SALES DIVISION

ELKHART, INDIANA

# Editorial

JUNE, 1932

**THE R.M.A. SHOW**

IT would not be difficult to advance argument indicating that the R.M.A. Show in Chicago, May 23-28, was not an outstanding success. The radio industry, however, is better served when an attempt is made to analyze and appraise all of the identifiable elements which go to make up the business of an industrial exhibition, such as was the Chicago show.

No one can truthfully say that the radio receivers displayed at Chicago are not far in advance of receivers now generally serving in the homes of the people. No one can truthfully say that the parts and accessories exhibited are not superior in design and workmanship to what went into the making of most of the receivers now in use.

So far as the radio manufacturers are concerned this situation is creditable. It reflects that the manufacturers have successfully applied themselves throughout two lean sales years to the task of bettering their products.

There could be no more sane manifestation of confidence in the future than that of producing better equipment. With improved buying power on the part of the public, no matter how or when this comes about, attractive, improved receivers will move more readily than would types with nothing new to recommend them.

To the readers of this journal it is not necessary to list the various improvements in the new receivers. It may suffice to call attention to but one trend which will have far reaching good results: we refer to the drift toward multiple loudspeakers. The unquestionable improvement in sound range and reproduction, by employing two or more speakers per receiver, gives dealers something new and better to sell.

Further, the gap is widened between the "hard times" midget and receivers which everyone would prefer to own.

For those who are thinking of the future of the radio business—those who are determined to succeed—the Chicago Show will stand out as a constructive undertaking, organized and carried out by progressive leaders.

**HIGHER BROADCASTING POWERS**

ONE result of the inability for the time being of the people at large to supply themselves with improved, highly selective radio receivers, is that it is difficult to determine side channel interference conditions where larger powers are granted to broadcast stations.

With reference to cross talk, an unselective receiver requires a signal of about five to one ratio—desired to undesired signal. Receivers now available permit of satisfactory reception with a ratio of 0.90 to 1. A modern receiver performs satisfactorily where the separation is as close as 5 kc., while the holdover receiver of 1929 or prior years requires the margin of about 14 kc.

It is the experience of the engineers of the Radio Commission that as transmitting station powers are increased the possibilities of interference increase. The fact that the smaller the transmitting power the less are the possibilities of interference at a given mileage separation of stations, presents the query as to just where larger powers are beneficial and where they are harmful.

▲

**GETTING READY FOR JUNE 23**

OF the 458 radio transmitting stations whose frequencies were measured by the Radio Division, Department of Commerce, in April, 59.6 per cent deviated less than 50 cycles from assigned frequencies. Fifty-three of the stations, however, deviated more than 200 cycles.

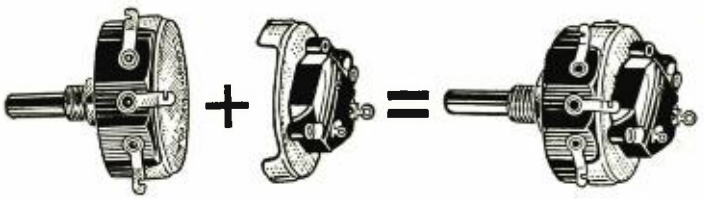
During May there was widespread activity at broadcast stations throughout the country in providing regulatory equipment which will enable the stations to meet the plus or minus 50 cycles variation allowable after June 23, this year.

All broadcast stations are disposed to do all possible to be ready for the test on the appointed day.

Donald McNicol

*Editor*

# AD-A-SWITCH



## another Clarostat achievement!

Remove the dust cap—replace it with an Ad-A-Switch—the one unit is now a complete and perfect Ad-A-Switch Volume Control and Switch combination.

Duplication of resistors to be carried in stock is eliminated, overhead is reduced, efficiency improved—and profits step in where there might have been a loss.

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BUILT-IN PROTECTION by means of the CLAROSTAT Line Ballast. Compensates for both Low and High voltages. For use in receivers and sound equipment with 85 volt transformers.

ACCESSORY TYPE, plugs-in between the electrical outlet and the cord. Protects 110 volt equipment from increased line voltage, automatically, not a fixed resistor. The Clarostat Automatic Line Voltage Regulator is made in five sizes from 50 to 250 watts.


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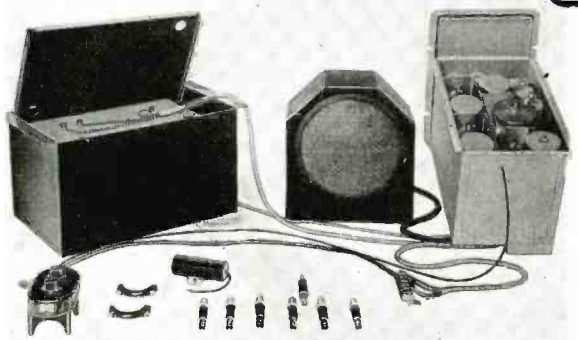
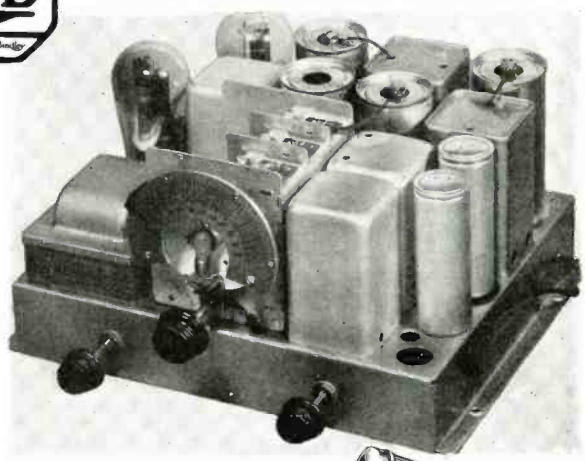
# SOLID MOLDED RESISTORS

## FOR MOTOR CAR RADIO A-B FOR CONSOLE RADIO





## Do Your Sets go "Sour" in Service due to poor Resistors?

The satisfactory operation of your receivers depends to a great extent upon the accuracy of your fixed resistors. Bradleyunit Resistors are used by the world's largest radio manufacturers, because their resistance value is stable under varying conditions of load, temperature, and moisture. They are not subject to wide fluctuation due to long use. Don't risk the reputation of your receiver with poor resistors. Get an Allen-Bradley quotation on your next order.

Interference from ignition systems in radio-equipped motor cars is suppressed with Bradley Suppressors. When used with suitable by-pass condensers in ignition circuit, shielded ignition cables are unnecessary.

Type A. Single Bradleyometer

Type AA. Double Bradleyometer

## BRADLEYOMETERS

The Bradleyometer is a potentiometer with approximately fifty solid resistance discs interleaved between metal discs.

The total number of discs can be arranged in accordance with any resistance-rotation curve.

One or more Bradleyometers can be arranged to operate with one knob. Mixer controls, T-pad and H-pad attenuators and other complex controls can be provided.

Type AAA. Triple Bradleyometer

Bradleyunit Resistors are made in five sizes, with or without leads, and are color coded to meet set manufacturers' specifications. These solid molded resistors are accurately calibrated and have great mechanical strength.

Allen-Bradley Co., 126 W. Greenfield Ave., Milwaukee, Wisconsin

**ALLEN-BRADLEY RESISTORS**

**Produced by the makers of Allen-Bradley Control Apparatus**

RADIO ENGINEERING

Production, Administration, Engineering, Servicing

JUNE, 1932

# Radio tower tuning and lighting

By VERNE V. GUNSOLLEY*

THE advent of steel towers with insulated footings has brought about new complications in the problem of tower lighting. The purpose of the insulated footings is to permit throwing the tower off resonance to any other reasonable frequency. If the lighting circuits are not properly designed the purposes of the insulated footings may be defeated, partially, if not completely.

A schematic of such a tower is shown in Fig. 1.

With the insulators (condensers) short circuited, the tower is the same as not insulated, and is a quarter-wave oscillator; in most cases of a frequency approximately equal to that of the associated antenna. When the antenna is in operation, reradiation from the resonant, or nearly resonant towers, causes signal pattern distortion which may be altered by resorting to methods of tower detuning.

One method of throwing the towers off resonance is to arbitrarily insert insulators (condensers) in the tower legs near the base as shown in Fig. 1. As may be seen, the effect is to change the tower from a quarter-wave oscillator to a Hertz linear oscillator as the capacity of the insulators is reduced without limit. The natural wavelength of the tower is thus shortened as the coupling to earth is decreased.

Obviously, if the capacity thus inserted is by chance the correct amount, the tower may so be tuned to one of its various modes of oscillation and at the same time thereby be resonant to some one harmonic of the associated antenna. In this event, though the desired signal pattern may have been obtained, many complaints of broadcast harmonics may result from the reradiation of the towers in the short-wave bands.

In the act of tower tuning, it is desirable to avoid not only the fundamental resonance, but harmonic resonance also. This may be accomplished with any method of continuously-variable tuning. Fig. 2 shows such a means.

### Checking Transmission

When adjusting such a tuning system, a calibrated short-wave receiver at a distance together with a field pattern measurement at the desired radius is essential so that for each satisfactory pattern the emission of tower harmonics may be checked. The ideal result is a circular pattern with no harmonics in the principal short-wave bands. It should be borne in mind that if the harmonic radiation is but 1/10th of one per cent, that is, 10 watts in 10,000 watts, it is still more than equal to the radiation from an amateur type transmitter employing a 210 oscillator. The ideal may be hard to achieve, especially in the case of a high-powered station, so that the results may be discouraging. Also if the transmitter layout is radiating due to any fault, its radiation may be mistaken for the failure to eliminate the harmonics from the towers. The job at best is a tedious one.

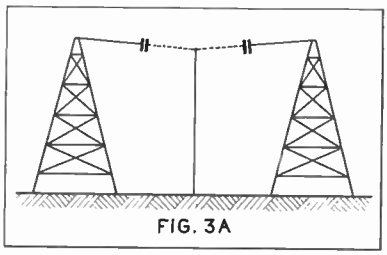
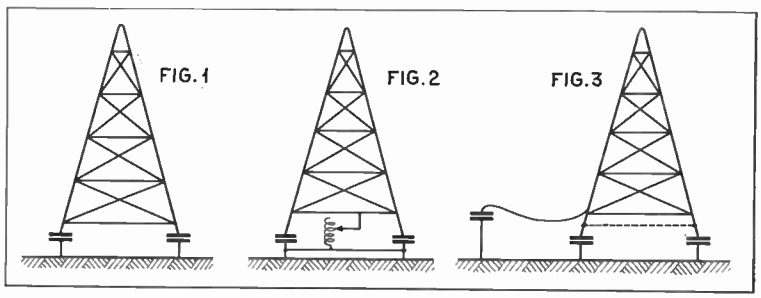


FIG. 3A

Another means of tuning the towers is shown in Fig. 3. Here, advantage has been taken of the insulation to permit changing the fundamental of the tower. A wire of low radio-frequency resistance, terminated by an insulator on a supporting post is attached to a tower leg after all the legs have been well bonded as shown by the dotted line. The insulated end may be grounded if desired. The effect of the grounding will be to make the tower a quarter-wave oscillator again, but it will not be exactly so, due to the disturbing influence of the increased distributed capacity to ground along the extension wire.

For towers that are not insulated, Fig. 3a shows a method of continuous tuning.

The tops of each tower terminate in cables extending towards each other and supporting themselves on an interconnecting insulated strand, which may be the flat top of the antenna, or a mere rope supporting a quarter-wave vertical antenna. (rope shown dotted). If the flat top is too long to permit the use of the proper length of cables required for correct detuning, it may be widened with more parallel wires and shortened. Needless to say, such a method makes it a tedious job experimentally to find the proper length of cable. A more convenient method that is equivalent is shown in Fig. 6.




*Consulting Engineer.

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**Engineering considerations of the half-wave versus the quarter-wave antenna for broadcasting.**

Fig. 4 indicates how the height of towers may be adjusted to agree with some desired frequency. Adjustable rods are added to the tops of the towers. This method is possibly more feasible in examples of tuning, rather than detuning, as, for instance, where the tower itself is used as the principal radiator.

### Tower Effects

Fig. 5 shows still another system of eliminating the tower effects from the signal pattern. Needless expense is the chief drawback in this design. Though in theory and practise it will be successful in most cases, it is impossible to exert the same control over the harmonic radiation from the short sections with the same ease as in the aforementioned cases. It must not be lost sight of, that here is a system that has many degrees of freedom and that due to the large amount of electrical elasticity in the many condensers may be far more efficient at radiating harmonics than the simpler electrical networks here discussed. With any method of tower detuning, the gain in any meridian of the antenna is on the order of *only a few decibels* and thus is not noticeable to the average listener, unless the signal level was originally at, or very near the noise level of the community. Surely, therefore, the improvement in Fig. 5 over Fig. 2 is still less consequential by far, and therefore negligible.

The writer has long been at a loss to understand the reasons for the large claims that have been made for the results obtained from tower tuning. The claims are the more remarkable when one observes how little improvement results from considerable increases in power.

Certainly, in the original plans, should be included the most efficient possible radiator. Large expenditures in reconstructing existing installations may be questionable. Some stations have hazarded thousands of dollars in achieving results that were perhaps more imaginary than real, and for which there was not justification from a commercial standpoint. However, they have played a useful part in bringing to the surface information that may profit others if heeded. Just how much gain is available would never be known unless some one made an attempt to find out. Wherever such changes can be made easily and inexpensively, they are not objectionable. It is needless to tear down towers in order to erect other towers. Even a considerable increase in height makes unnoticeable difference so long as the power remains the same.

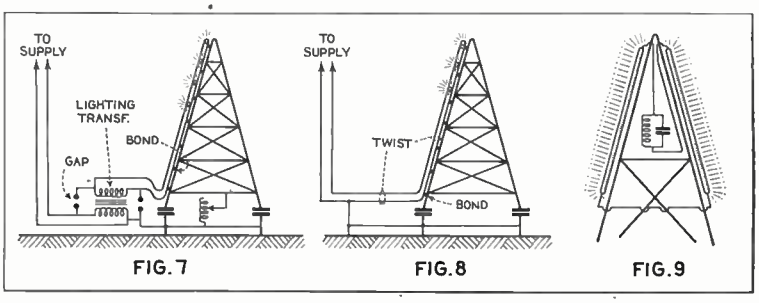

FIG.7 FIG.8 FIG.9

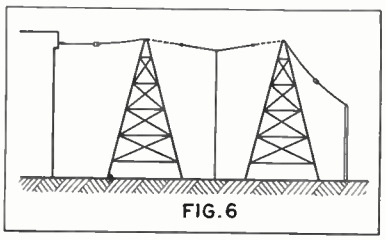
FIG.6

What is gained in antenna height is lost in amperes due to the higher resistance, so that the meter-amperes remain practically constant. It is for this reason that the writer believes no very startling results will obtain from the replacement of a quarter-wave antenna by a more expensive half-wave tower-antenna. Nothing sensational has occurred in this vicinity (Minnesota) from those that have been erected.

Where adjoining lands or structures will permit a variation of Fig. 3a, as shown in Fig. 6 may prove useful. The difference is that the extension cables have the most available direction and therefore permit more convenient adjustment to the correct length. Furthermore, any complications due to a long flat top are eliminated.

### Tower Lighting

With the aforementioned principle in mind, it is plain that tower lighting schemes should not interfere with the relations so tediously arrived at. Obviously the lighting system should be in place when the adjusting is in progress, and it must be of such design that it will not interfere with the freedom of adjustment. No problem is involved where grounded towers are used provided the system is "grounded" to the towers at several places along their length by effective bonding. The system then becomes integral as an oscillator, and is electrically a part of the tower. Such towers are shown in Figs. 3a, 4 and 6.

In Fig. 7 is shown the lighting system for Fig. 1 and Fig. 2. Here, the capacity between the lighting transformer windings is added in parallel with the footing capacities and behaves like them. One transformer is required for each tower.

For Fig. 2, the same system as in Fig. 1, will be satisfactory. The inductance tunes all capacities together. In this case:

(1). Choose a transformer well insulated between primary and secondary coils, and protect this insulation by spark gaps at both coil ends as shown. Tuning and lightning surges may set up excessive voltages across the capacity reactances.

(2). Bond one side of the secondary light line, which may be bare, at several places along the side of the tower.

(3). House the condensers from wet and stormy weather. Clean them periodically.

For Fig. 3 the same principles may be applied as for Fig. 2; but if Fig. 3 is grounded at the post no transformer is needed. See Fig. 8. In this case the lighting system is a part of the oscillator down to the grounded point where its radio-frequency potential is zero, and thus cannot affect the tuning of the tower.

In the case of Fig. 5, gas lighting may be resorted to, employing gas pipe with insulated couplings at every insulated section of the tower. Electrical lighting systems for the foregoing are impracticable since an insulating transformer is required at every section. A floodlight of the projection type placed at the base and focused along the vertical axis of the tower upon aluminum painted surfaces would be very effective.

As a matter of interest is shown the

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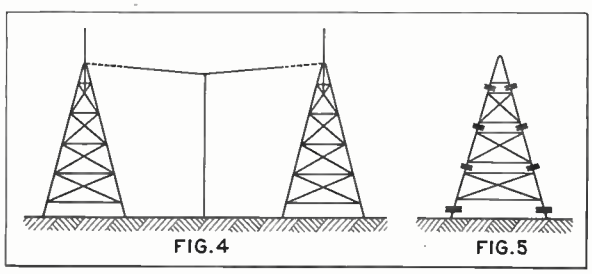
FIG.4 FIG.5

# Design of lens scanning systems for television

IVAN BLOCH, E. E.*

THE purpose of this article is to demonstrate how the design of the lens scanning system in television apparatus is accomplished. It is rather interesting to notice how many of the concerns now engaged in the production of television receivers have usually disregarded engineering practice and have designed their machines by the unreliable method of cut-and-try. Obviously, this procedure makes for failure, for, in television, the designer is faced with so many additive problems of distortion that he cannot be too particular to, at least, remove those which obviously can be avoided. The optical part of a television receiver or

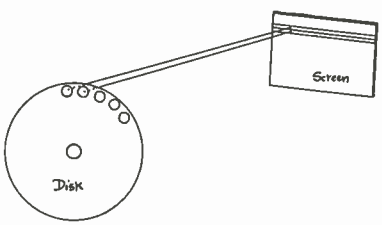


Fig. 2.

transmitter is of primary importance, but it is not to be forgotten that unless the receiver and transmitter equipment operate properly, no matter how perfect the disc and allied system are, the results will be poor. Good radio engineering is needed in television and, coupled with the intelligent usage of optics, one may expect satisfaction.

The difficulties encountered in the design of lens discs will be pointed out as the material is explained and solutions will be suggested wherever possible.

Certain parameters are present: the size of the image to be projected; the focal length of the lens; the aperture of the crater lamp anode (or if other means are used such as the Kerr cell; modulated arc, etc., the aperture of the restricting diaphragm); the pitch of the disc spiral—all of which are interconnected.

### Picture Elements

In an enlarged image, the same number of so-called picture elements is present as in a smaller image. Each element therefore must be enlarged without altering the original picture ratio which, at the present time, is 6 to 5, that is, sixty vertical elements and seventy-two horizontal ones. Hence, each lens merely serves to pick up the brilliant spot of light which is definitely dimensioned by the aperture in the anode screen of the crater lamp or by the restricting diaphragm of whatever source of light is used. This is shown diagrammatically in Fig. 1.

From elementary optics, the following relationship is obtained :

$1/f = 1/p + 1/q$ ..... (1)

where f = focal length of lens
p = distance between principal plane of lens and object
q = distance between principal plane of lens and image.

From the geometry of the figure,

$\frac{B}{A} = \frac{q}{p}$, but $\frac{B}{A} = M$, the magnification,

so that $p = q/M$ ..... (2)

It may be seen that in order to find the magnification needed for a certain projected image,

$\frac{\text{Height of image}}{\text{No. vertical lines}} = M$..... (2a)

Size of aperture

in which the size of the aperture inversely affects the magnification: the greater this aperture, the less the magnification, etc.

From equations (1) and (2),

$q = f(1 + M)$ and $p = \frac{f(1 + M)}{M}$

thus correlating the focal length, the magnification and the various distances necessary for a certain image height. The width becomes automatically fixed for a certain picture ratio.

Complete surface projection is attained by rotating lenses located on a spiral. Each lens is set radially an increment less than the preceding lens and when rotated will cast its projected screen element correspondingly lower along the image height as shown in Fig. 2.

If, for a certain magnification the radial increment is too small, overlapping of the screen elements occurs. Conversely, if the radial increments are too great, the screen elements will be separated, resulting in dark lines.

The matter of element overlap is important. Some manufacturers claim 60

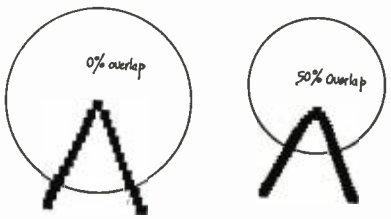


Fig. 3.

per cent is correct, others 50 per cent, and so on. Most of them base their figures on convenient disc sizes. Why is any overlap necessary? If we assume a perfect lens disc, where each vertical picture element is tangential to the one below and above it, and where each element is square, then we should obtain a perfect and evenly illuminated surface. (Note: angular distortion not accounted for, as will be seen later on). But when the source of light is being modulated by the television signals, it will be seen that the image therefrom is strangely "sketchy." That is, one is definitely conscious of its being made of picture elements. By overlapping the picture elements a trifle, this effect is somewhat alleviated. This may be shown in a rough way in Fig. 3.

However, with discs such as can be readily made, tangential contact is difficult. Furthermore, with round crater apertures, the light density is less at the edges of the resulting horizontal lines than at the center. By overlap-

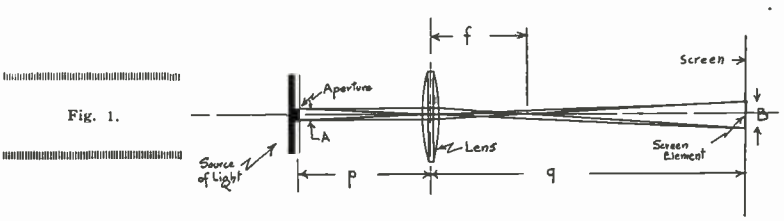


Fig. 1.

* *Chief Engineer, General Television Manufacturing Corporation, 55 Van Dam St., New York.*

ping, this uneven distribution may be compensated. With square apertures, there is no other reason for overlap than to slightly diffuse the image elements.

The necessary amount of overlap is thus an undecided quantity. Forty per cent., by actual experimentation, seems correct and gives a pleasing effect to the image. Over 50 per cent. begins to over-diffuse the detail. Sixty per cent. is decidedly poor. (These figures are the result of actual experimental research, where changes in overlap were effected by various aperture sizes for fixed lens relationships.)

To return to the question of radial increments. The source of light is motionless—the lenses are the parts which swing the light spot on the screen. Hence, motion of the lenses will cause this spot to move, but in the ratio of magnification. This may be resolved into a problem of moment arms. The luminescent spot of neutralizing gas in the lamp acting as fulcrum, the lens as "the force" and the screen element as "the reaction." A motion of the lens hence causes the arm to swing about the anode aperture (roughly speaking). From Fig. 4, the following may be deduced:

$$\frac{a}{b} = \frac{p+q}{p} = \frac{q}{p} + 1 = (M+1)$$

$$\text{or } b = \frac{a}{(M+1)} \quad \ldots\ldots\ldots\ldots\ldots \quad (4)$$

Where b is the distance through which the lens is moved to obtain a swing a. 2a is usually taken as the total image height minus the height of one screen element, that is, when n is the number of lines of the system.

2a = Total image height × (n-1)/n

From equation (4), the radial increments are then found:

$$\text{Radial increment} = 2b/(n-1) \qquad (5)$$

The denominator of (5) is not n, for there are (n-1) increments from the first lens center to the last lens center.

With the above equations, the problem becomes simpler to visualize and overlap provisions can now be taken care of in the following manner:

Fig. 5.

If the percentage overlap is W, then a certain apparent crater aperture is used in the calculations, which equals $\frac{(100\text{-}W)}{100}$ times the actual crater opening. That is, equation (2a) becomes:

$$\text{Magnification } M = \frac{\text{Total image height}}{\frac{n}{\frac{100\text{-}W}{100} \times \text{crater aperture}}} \qquad (6)$$

With these formulas, an actual design may be demonstrated as follows:

60-line system, 6 to 5 picture ratio.

Given: anode aperture of crater lamp, 0.02 inch.

Focal length of lens, 1.5 inch.

Image height desired, 10 inches.

40 per cent. overlap.

Then:

$$M = \frac{\frac{10}{60}}{0.6 \times 0.02} = 13.9$$

$q = f\,(1 + M) = 1.5\,(13.9 + 1) = 22.35$ inches

$p = q/M = 22.35 / 13.9 = 1.61$ inches

$$2b = \frac{10 \times \frac{59}{60}}{13.9 + 1} = 0.66 \text{ inch}$$

Radial increments $= 0.66/59 = 0.0112$ inch.

From 2b, we may find the circumferential distance between lenses. The image ratio being 6/5.

$$\frac{6}{5} = \frac{\text{Width}}{\text{Height}} = \frac{w}{2b},$$

$$w = \frac{6 \times 2b}{5} = \frac{0.66 \times 6}{5} = 0.792 \text{ inch}$$

As each lens is 6° from the next for this system (for any system, 360°/n), the outer circumference is $60 \times 0.792 = 47.52$ inches or a diameter of 15.13 inches, or a radius of 7.565 inches.

The diametral dimension of the lenses is obviously limited by the distance between radii, but not at the outer diameter. The distance between radii, decreases as one approaches the center, which derives from the length of arc subtended by an angle. The inner diameter, that is, the diameter determined by the lens center at the lower end of the spiral is:

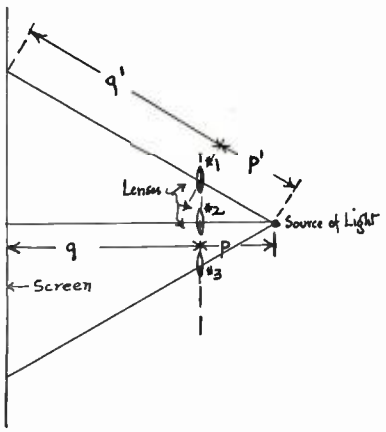


Fig. 6.

$$15.13 - 2 \times 0.66 = 13.81 \text{ inches}$$

which yields for the distance between radii (minimum distance)

$$\frac{13.81\pi}{60} = 0.725 \text{ inch.}$$

Usually 0.1 inch is sufficient material between adjacent lens edges and therefore lenses 0.625 inch in diameter will do.

It may be seen that the image is distorted by the decrease in diameter, Fig. 5. This is inevitable, but it must be remembered that the distortion decreases with increase in disc size, for the linear distance between radii, i.e., chords, is changed proportionately less when the radial distance is great.

In regard to the focal length of the lenses used, as luminous intensity decreases with the square of the distance, the shorter p and q are, the more light will reach the screen. As shown before, f governs p and q for a given magni-

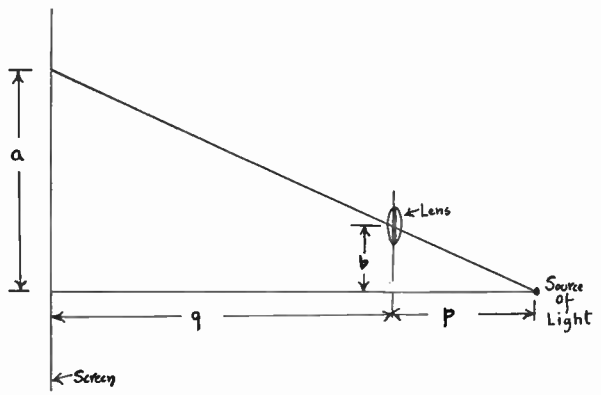


Fig. 4.

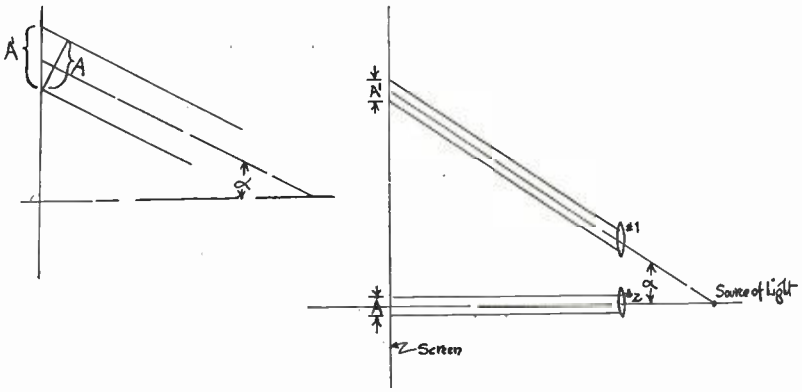


Fig. 7.

fication and thus the shorter the focal length, the better, within limits for a given lens diameter. Several factors limit the focal length and will be discussed thoroughly.

The first lies in the actual dimensions of the lens. The focal length of a lens expressed in terms of its radius of curvature is

$$f = \frac{R}{n-1}$$

Where R is the radius of curvature and n is the index of refraction which may be taken as 1.6. Hence R = 0.6f approximately. For very short focal lengths, the radius of curvature becomes very small and the lens approaches spherical form. Furthermore, as it becomes thicker, optical errors are introduced which make it impossible to use.

The second limiting factor is complicated and as a rule has been ignored or the resulting distortion blamed on the screen, etc.

Consider Fig. 6. where the lens positions are indicated, viz., the center position, the two extreme positions. If the mid-lens is properly distanced at p and q, it is not difficult to see that No. 1 and No. 3 are not correctly placed for sharp focus. The deviation may be derived algebraically as follows:

From Fig. 6,

$p/p' = \cos \alpha$ or $p' = p/\cos \alpha$
$q/q' = \cos \alpha$ or $q' = q/\cos \alpha$

Which indicates that the relationship between the focal length and the distances p' and q' is $1/f = 1/p' + 1/q'$ for 'f' has not been increased by an amount equal to the reciprocal of the cosine of the angle $\alpha$. The closer $\cos \alpha$ is to unity or which is the same, the smaller the angle is, the less will be the error due to deviation from focus.

Now $\tan \alpha = \frac{b}{p}$

and from equation (4) $b = \frac{a}{(M+1)}$

Since $M = q/p$, then

$$b = \frac{\frac{a}{\frac{p+q}{p}}}{} = \frac{ap}{p+q}$$

Therefrom $\tan \alpha = \frac{\frac{ap}{p+q}}{p} = \frac{a}{p+q}$

which may be expressed in terms of the magnification and the focal length as

$$\tan \alpha = \frac{a}{f\,[(1+M)+(1+1/M)]}$$

and if we express $(1+M)$ by K and $(1+1/M)$ by K' since M is a constant, then,

$$\tan \alpha = \frac{a}{f(K'+K)}$$

and as we wish to make $\alpha$ small, the larger f is, the less will the error be.

As explained in a foregoing paragraph, in order to obtain as great a light intensity at the screen as possible, all distances must be kept at a minimum. Thus, the designer must choose such a focal length that will not only minimize distance but which also will not introduce the error expressed algebraically above.

Deviation in focus for extreme lens positions is responsible for the "tailing" effect of the light element on the screen. The distorted spots are: 1, out of focus; 2. out of shape, and 3. have a luminous tail. The first effect has been discussed. The third is due to spherical aberration in which the beam of light is refracted unevenly for various positions of the lens. The only correction possible is in the construction of the lens itself, and as cheap lenses are usually used, cannot be readily overcome. The second effect may be analyzed as follows from Fig. 7.

Not only is the spot out of focus, but it is projected angularly on the screen.

If we disregard the change in p and q due to angularity, we note that—

$$\frac{A}{A'} = \cos \alpha,\ A' = \frac{A}{\cos \alpha}$$

as before $\alpha$, (or $\tan \alpha$) must be made small, which may be accomplished by increasing f.

These three effects, which may be classified as angular lens distortion, are especially flagrant in that the density of the light spot is decreased at the extremes of the projected image. This may be seen in one instance from the expression for the screen element area (in the case of square elements),

$$(A')^2 = \frac{(A)^2}{(\cos \alpha)^2}$$

Recapitulating, we have:

1. The distortion of the screen element due to its being out of focus is proportional to $\tan \alpha = \frac{a}{f(K'+K)}$

This may be lessened by increasing f.

2. The decrease in density due to the angular projection is proportional to

$$(A')^2 = \frac{(A)^2}{(\cos \alpha)^2}.$$

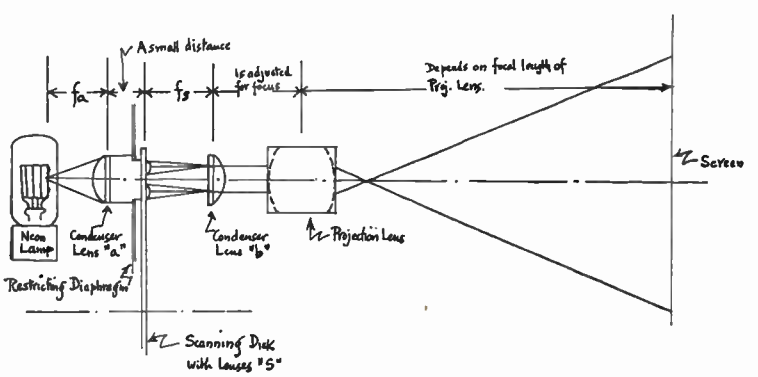


Fig. 8.

This may be lessened by increasing f.

3. Spherical aberration can only be corrected at the lens itself and cannot therefore be economically controlled.

The problem therefore resolves in choosing a focal length which will be large enough to reduce angular lens distortion and yet which will not be so great as to increase all distances beyond the point of efficient light projection. Empirical data is being collected which will allow certain definite limits to be determined. At the present time, for a lens disc such as dimensioned in this article, focal lengths of between 1.5 inch to 2 inches are satisfactory, with 1.75 inch as a happy medium.

There are certain interesting methods whereby distortion may be brought to a minimum using very short focal length lenses. One is indicated in Fig. 8.

The condenser lens a serves to bring the emergent beam of light from the source of light into parallel rays to the lens disc. As parallel rays will converge at the focal point of the lenses, if a screen were placed at f, a small image would be observed. However, the rays continuing from the scanning disc lenses are divergent after passing the focal plane, hence another lens b is used to parallel them again into a projection lens. This system in reality is no other than a lantern or a motion picture projector, but the problem is slightly different due to the divergent effect which must be corrected as indicated. This system is expensive and unless all auxiliary lenses, especially the projection lens, are well ground and corrected and of short focal lengths, light losses will be great and the resulting image will lack brilliancy. However, from an optical viewpoint, the system is quite correct.

Another solution to the problem of "out of focus positions," which is rather interesting, is the use of a spherical screen so placed and dimensioned that each screen element will always be in focus and at right angles to the beam of light. There will still be a slight error due to increase in distances p, but this becomes negligible.

The author believes that many engineers have been puzzled by the distortions observed in lens scanning systems and that this article, in pointing out the sources, will bring about a systematic collection of empirical data which will allow intelligent lens disc scanning system design.

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## NEW PLAN TO COLLECT FROM BROADCAST STATIONS

NOT contented with having driven millions of persons out of business by imposing new taxes, fees, inspection costs, employment regulations, compensation insurance, etc., Washington now is talking about further bleeding the radio broadcast stations which are struggling in a period of depression to establish a new industry.

A senator from a small state up in the mountains reports a bill from the Interstate Commerce committee which proposes the collection of annual fees from the broadcasting stations. This schedule of fees would range from $5,000 for a high-power, clear-channel station to $120 a year for a local station.

With reference to this proposed grab, Philip G. Loucks, managing director of the National Association of Broadcasters, says:

"With the broadcasting industry suffering from depressed business conditions, the increased music license fees and the imposition of government license fees would fall as a severe burden on all stations."

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*THE FEDERAL RADIO COMMISSION (SERVICE MONOGRAPH NO. 65. By Laurence F. Schmeckebier. Published by The Brookings Institution, Washington, D. C.* 159 pages. 8vo. 1932. Cloth. $1.50.

The growth of Federal control over radio from the time when its use was confined almost entirely to communication between ships to its present extensive development is described in this volume.

In the book are discussed the cases resulting in the breakdown of the earlier laws, the efforts made to substitute order for chaos, the creation of the commission, the legislative and administrative development after the appointment of the commission, its activities, and its plan of organization. The volume includes also the laws relating to Federal control of radio, a bibliography of books and articles on that subject, and data on the information required by the commission before a license is granted.

*FIRST PRINCIPLES OF TELEVISION. By A. Dinsdale, John Wiley and Sons, New York. 237 pp. Cloth. Price,* $3,50.

In this new book Mr. Dinsdale presents a complete, interesting and instructive review of television systems proposed and in operation, both in this country and in Europe. All of the essential technical details of television are gone into thoroughly—a particularly instructive chapter being that on image structure.

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## MECHANICAL BROADCASTS

AT a session of the Federal Radio Commission held at its offices in Washington, D. C., on May 17, 1932, it is ordered:

That Paragraph 176 of the Rules and Regulations of the Federal Radio Commission be, and the same is hereby, amended to read as follows:

"A mechanical reproduction shall be announced as such except when its use is merely incidental, as for identification or background. The exact form of announcement is not prescribed but the language shall be clear and in terms commonly used and understood. The following are examples of statements sufficient for the purpose:

a. 'This is a phonograph record.'
b. 'This is a player-piano record.'

"In all cases where electrical transcriptions made exclusively for broadcast purposes are so constructed as to record a single continuous program upon more than one mechanical reproduction, rather than a recordation of the entire program upon a single mechanical reproduction, the announcement required hereby shall be made at the commencement of each such program and in no event less than every fifteen minutes. All other announcements required hereby shall immediately precede the use of each separate mechanical reproduction.

"This order shall be effective the first day of June, 1932."

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## RADIO TOWER TUNING AND LIGHTING

(*Concluded from page* 8)

system in Fig. 9. Here neon tubes are placed along the top corners of the tower and driven from the tuned circuits in each tower. Modulation produces an automatic flasher out of this device; that is very interesting also as an indicator of the momentary degree of modulation. It is effective only as long as the antenna is excited and must be supplemented by oscillators of a directional nature that could be directed at the tuned circuits in the towers; or by a regular lighting system that could be disconnected during broadcasting periods. Not a practical system, though interesting.

As a last resort, in some cases, it may be advisable to use a wind-driven generator with associated storage batteries not greatly unlike the system in use on airway beacons.

It is believed that by one or more of the principles given, it will be possible to readily tune and light any insulated tower installation that may be considered in practise.

# Dynamic transconductance meters

By RINALDO DE COLA*

THE dynamic transconductance of a tube is the ratio of alternating current in the plate circuit to a given value of alternating voltage impressed upon the grid. The determination of this quantity in preference to the amplification factor or the alternating plate-circuit resistance, is natural since it is equal to the ratio of these latter quantities, i. e., $Sm = \mu R_p$. Consequently a test on Sm is really a test on all tube characteristics. The utility of a tube as a detector, amplifier or power-tube, is generally best indicated by its transconductance factor. It is only natural that this quantity would be most desirable in characteristic tests, at least in the fields of servicing and testing.

Although the dynamic method of determining the transconductance factor is in itself quite simple in principle, since it merely requires a small signal voltage on the grid and some method of determining the alternating-current change in the plate circuit, unless extreme care is exercised in the design of the instrument it will be impossible to obtain consistent and reliable readings. Accurate means must be available for keeping plate voltages and grid biases upon the tube under test within close limits.

For, a small change in either of these voltages results in an appreciable change in Sm readings. Also it is very important that the signal voltage impressed upon the grid should be capable of close regulation for reasonably accurate measurements. To equip each circuit with appropriate meters would result in rather large, unwieldy, uneconomical designs. But since it is comparatively easy to dispense with individual meters, and resort to indirect but equally accurate means of adjustment, this method is much to be preferred. A schematic of the transconductance circuit developed by an electrical instrument manufacturer is shown in Fig. 1.

The simplifications introduced by the use of the principles shown in the diagram are the result of much consideration of the problems here considered. To any one faced with the problem of testing radio tubes, it is very important that the test equipment, in order to cope with the numerous types of tubes, be sufficiently universal to embrace all types, some of which date far back, at least so far as radio is concerned.

The dynamometer type a-c. meter, shown in the diagram, is operated as a voltmeter by means of the switch S shown. With this switch in the line test or (1) position, (contacts 1 and 2 closed; 3 and 4 open) the 20-volt transformer winding which is permanently connected to the moving coil A, of the dynamometer a-c. meter, is also connected across the resistor $R_1$, in series with the stationary coil, B. The resistance of $R_1$ is such that with 20 volts across $R_1$ and coil B in series, it will pass 5 ma., which is sufficient to cause a deflection of, say, 2,000 micromhos on the meter scale.

Consequently, if any variation occurs in this voltage, the transformer primary resistance R, can be adjusted so that the meter reads just 2,000. This adjustment, since it is made in the primary, also insures that all other secondary voltages are correct. This adjustment should be made only by a tube inserted in one of the test sockets. When the switch is placed in position (2), (contacts 3 and 4 closed; 1 and 2 open), the a-c. meter is placed in the tube plate circuit. The a-c. current in the plate circuit, however, only flowing through coil B, resistor $R_1$ having been disconnected. The transconductance of the tube can be read in this position.

To obtain correct transconductance

(*Concluded on page* 15)

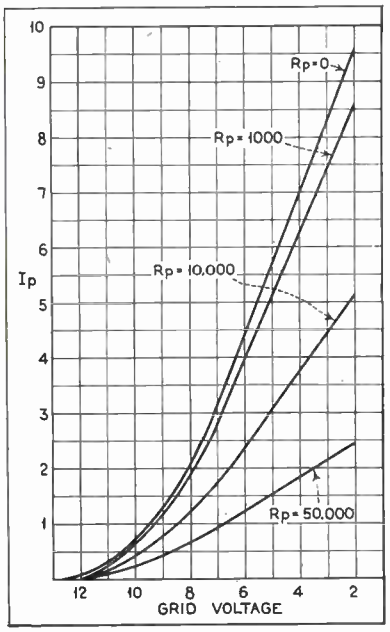


Fig. 2. Showing effect of external resistance on Sm for 227 tube.

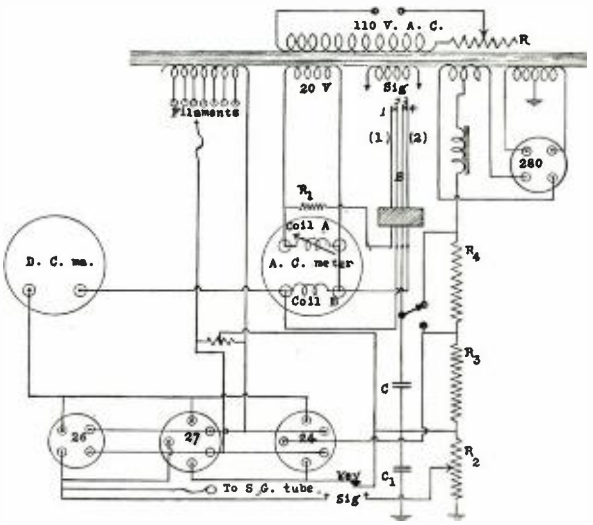


Fig. 1. Schematic of transconductance meter.

*The Hickok Elec. Inst. Co.

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**Progress is being made in developing practical systems for testing tube characteristics**

# B power supply devices for automobile radio

By H. E. THOMAS* and L. P. KONGSTED*

A REVIEW of radio receiver circuit development of the past two years gives a good introduction to the present conditions bearing on design of B power devices for automobile radio receivers. The first commercial automobile radios presented early in 1930 were naturally of the t.r.f. variety; they had either five or six tubes, magnetic speakers and gave output of an average well under one-half a watt with dubious audio fidelity and sensitivities ranging between twenty and one hundred microvolts. They had the tube filaments supplied directly from the storage battery and usually had four forty-five volt B batteries serving as plate supply. They gave, through the ironing out of the difficulties of installation and ignition interference, a background of experience which has influenced greatly the basis on which the present day receivers have been built.

In point of electrical performance it was found that their sensitivity was not adequate; that distance reception comparable to that obtained on regular household sets could not be realized. Changes in receiving conditions due to position of the car, particularly in relation to steel framework structures, produced fading which was many times worse than that experienced in other commercial receivers. The quality of speech and music was very poor; overall audio-frequency response that was limited between 200 and 2,000 cycles, together with mechanical resonances in the magnetic speaker, gave reproduction comparable to the standards of three years previous.

Radio-frequency interference originating in the ignition system of the car was perhaps the second major fault of automobile receivers; its elimination was often a tedious process of cut, try, and listen, with average resultant satisfaction not always complete. In this specialty a radio automotive background, very difficult to obtain because of its requirements on the versatility of a serviceman, had to be acquired through time and normal experience with installations.

Most of all, however, was the difficulty encountered with the B batteries. They were expensive, bulky, and required special mountings that were at times difficult to make. The usual position for the batteries under the floor boards of the rear portion of the car was sometimes impossible due to chassis braces and stays that existed in certain types of automobiles. Replacement of these gave an item of expense that amounted to an average cost of operating at two cents per hour. At three hours use per day, six months was the usual life of a set of batteries.

*Engineering Department, United American Bosch Corpn.

## Comparable to Home Receivers

While this background of experience was being acquired, the radio industry progressed in the way of circuit developments and tube improvements to the point that we have to date five important developments bearing directly upon the manufacture of successful commercial automobile receivers. The end has been reached that automobile receivers produce the quality of sound reproduction at a sufficiently adequate output with a sensitivity that compensates for the automobile's lack of antenna pickup, to give us a radio set with minimum installation and ignition difficulties comparable to the commercial feasibility of a modern home receiving set.

1. The first of the five developments mentioned above is the superheterodyne circuit. The old t.r.f. sets, to produce a sensitivity that was needed with the limited automobile pickup, could not be manufactured with sufficient uniformity to give a stable gain in the r-f. amplifier. Even at best, with careful adjustment and manufacture, sensitivities of two years ago are in no way comparable to what can be obtained today using a superheterodyne circuit. The average sensitivity of a good automobile set is not well under 1 microvolt per meter.

2. New tubes, particularly adaptable for automobile receivers in that they have very low flow filament drain, have been developed. These tubes take .3 ampere to heat the filament against 1.75 ampere used in the 224 type of three years ago. The total filament drain of the older sets averaged 3½ amperes. A 7-tube set of today using the new tubes takes 2.1 amperes. In addition, these tubes make provision for variations in the terminal voltage of the storage battery and present no difficulties that were present in the way of tube life in the old type 224.

3. The field of automatic volume control has been widened a hundredfold since the beginning of 1930 until today almost every current model of household receiver has it. This particular development seriously started growing at the time automobile radio became commercial and the circuit background that we now have pertaining to it has reached the point where it is commercially adaptable to almost any receiver. The necessity for this is of course obvious in the elimination of fading, as mentioned above, so prevalent in the old receivers.

4. The demand for power output has been answered in the pentode tubes developed in the last year. With the greater power-sensitivity of these tubes, incorporated with the new filament, there is now available from two pentode tubes power in excess of one watt. With the increase in average automobile driving speed of the last two years, the necessary output power has been raised proportionately so that an output of under one-half watt as previously given would be very faint response for average driving conditions.

5. The development toward the elimination of the B battery problem has come to a commercial success in the way of B power supply devices. The present-day B eliminator operated from the storage battery is usually of less size and weight than one of the 45-volt B batteries. Its mounting problems are few, its cost is but little in relation to battery replacements and its attention and service requirements are practically nothing.

## Design of B Supply Unit

In the design of a B power supply device operated from a 6-volt storage battery, five fundamental requirements must be adhered to:

1. The device must be small, compact, light and easily mounted. The usual place to attach it is on the dash and in no way should it interfere or be inattachable to the front of the car where the rest of the receiver must be located.

2. It must be efficient in that too much additional drain upon the storage battery of the car must not take place. A current drain over 3 amperes for such apparatus is undesirable.

3. It must be noiseless. An inherent feature of voltage conversion devices is that sparks or electrical contact disturbances exist. This requires that sufficient and adequate filtering must be self-contained with the unit. In the case of interrupter type of converters the filtering is somewhat more difficult; rotating conversion devices have disadvantage in the mechanical noise that they generate.

4. The device must be durable and require a minimum of service. It should

not be of such complication and such frail construction as to require attention. The minimum adjustment period of such a unit should be well over 2,000 hours of actual running.

5. It must be inexpensive. An economic estimate is that a list price of over three times that of a battery replacement is expensive for this unit. With battery replacements on the average of every six months a unit should earn its own keep in less than two years.

The Bosch magmotor, recently announced, incorporates the desiderata mentioned in these five points. It measures overall 6½ inches by 3½ inches. With the filter attached and in its container the overall dimensions are 10 inches by 5¼ inches by 4 inches. It has a plug attaching to the chassis through which it receives the 6-volt storage battery supply and which also delivers plate voltage to the tubes.

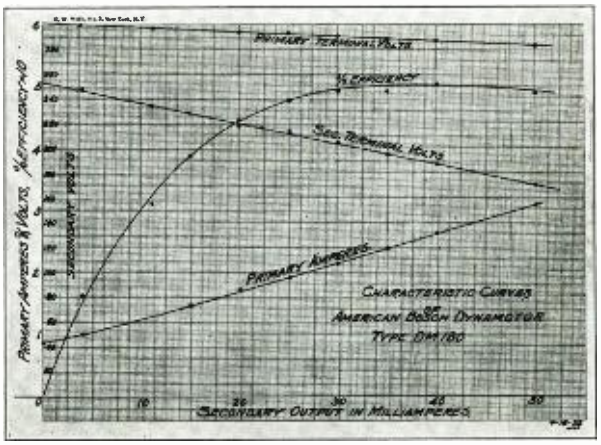


Fig. 1. Characteristic curves of dynamotor.

### Efficiency

Here may be noted an ingenious space saving arrangement of armature, field structure, poles and permanent magnet. Instead of the armature rotating perpendicularly to the plane of the U-shaped magnet it is so placed as to be parallel to it. Thus is utilized the space within the bend of the magnet that is usually not taken up in other designs.

Its efficiency can be noted on the curves, Fig. 1. At full load of 40 milliamperes and a terminal voltage of 180 volts it has an efficiency of 50 per cent which is relatively high. At this load it draws from the A battery 2.6 amperes. The reason for this efficiency relative to machines of similar make is due partly to the permanent magnet used as the field. This magnet consumes no power to reduce the overall efficiency of the unit. Core and windage losses have been made very low. Friction losses are at a minimum since bearings are of the ball type. They require oiling but once in the useful life of the unit. Brush noise and sparking on the commutators have been eliminated through a filter system accompanying the magmotor itself. Very careful design of this filter system was necessary in that high frequency oscillations were found to exist through distributed capacity of the armature winding which, together with its inductance, produce oscillation in the vicinity of 1 meter wavelength. Filter lead lengths were of prime importance at this high frequency and acted as chokes with much more effect than regular coil wound chokes.

In an inspection of the armature slots we see that they are skewed. The reason for this lay in further reducing noise to a minimum. With straight slots abrupt entrance of the armature teeth into the field produces vibration and hum. The more gradual entrance effected by skewing the slots produces improvement. Mounting of the entire unit on rubber helps also to reduce the mechanical noise transmitted. Accoustic treatment of the interior of the container is another step toward the same end.

The 6 volt brushes are of copper graphite composition and the brushes on the high voltage side are of high resistance carbon.

Seven sets of coils for the low tension and 14 sets of high tension windings give an optimum ratio of copper to iron to be compatible with the various design factors upon which mechanical dimensions and manufacturing tolerances place limitations.

Complete enclosure of the unit has been provided for. Any dirt or dust particles reaching the ball bearings considerably affect efficiency since the machine is such a free running, accurately balanced unit. Shielding of the bearings from brush and commutator particles was also found necessary and internal oiling with a special lubricant is necessary but once in every 2,000 running hours.

Under normal load the heating of this unit was evidenced by a temperature rise on the frame of but 15° Centigrade. A considerable factor of safety is here noticed and overloads as heavy as 75 milliamperes can be carried for several minutes without damage resulting.

The unit has an intermediate voltage tap to deliver 100 volts for tube screen supplies. This bleeder system is included in the filter.

▲ ▲ ▲

## DYNAMIC TRANSCONDUCTANCE METERS

(*Concluded from page* 13)

readings for any tube it is essential to keep the external plate circuit resistance very low in comparison to the internal resistance. To show why this is true a group of curves was plotted (Fig. 2), showing the change in plate current with various values of grid potential, and under different load conditions.

Since the transconductance can be obtained by finding the slope of any point of these curves, from the relation $Sm = dI_p / dE_g$, it is evident that for appreciable load conditions the value of transconductance will be smaller than at zero load. For very high plate-circuit resistance the curve would practically coincide with the grid voltage axis. This effect is still true of conditions where the IR drop in the load is compensated for by increasing the plate supply voltage an equivalent amount.

Any resistors, such as $R_2$, $R_3$ and $R_4$, in Fig. 1, would therefore give erroneous values for transconductance. Also, since tubes with widely varying plate circuit resistance must be tested, the amount of deviation from the correct reading will be entirely different in different tubes.

Being only concerned, however, with providing a low resistance path to ground for the a-c. component of the plate voltage, the use of large by-pass condensers across these resistors suffices. The value of C and $C_1$ is 12 mfd. each. These condensers are sufficient to reduce the resistance to ground to about 200 ohms at sixty cycles, which is the signal supply voltage frequency, appearing in the plate and grid circuits.

It is of utmost importance that considerable attention be devoted to the design of the "Sig" winding. The resistance of this winding should be as low as possible. This is necessary where tubes may draw an appreciable amount of grid current, either due to ionization within the tube or pure electron current, which would cause an appreciable IR drop in this winding, and cause incorrect readings of the Sm meter. Design need not be any more liberal than the normal filament supply winding.

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

**This history was begun in the January, 1932, issue of RADIO ENGINEERING, and will be continued in successive monthly issues throughout the year. The history is authoritative and will record all important dates, discoveries, inventions, necrology and statistics, with numerous contemporary chronological tie-in references to events in associated scientific developments. The entries will be carried along to our times.**

**Part VI**

**1854** (223) Charles Bourseul, in France, describes the action of and suggests the design of a telephone transmitter.

(224) Frederick W. Schilling dies. (Born in Germany, 1775.)

(225) James Bowman Lindsay, in England, transmits signals across a river using a high tension induction coil as a source of energy. Metallic plates immersed in the water on each bank of the river, and separated a distance about equal to the width of the river, served as the medium for the transfer of the electrical impulses. A distance of 1,500 feet was thus bridged over.

(226) Georg Simon Ohm dies. (Born in Bavaria, 1789.)

(227) Latimer Clark is appointed chief engineer of the Electric Telegraph Company, in England.

(228) Wade and Speed telegraph lines in the central western states are merged with the existing Western Union lines; the latter using Hughes' apparatus.

**1855** (229) Cromwell F. Varley, in England, invents the gravity battery.

(230) The springjack switchboard is introduced by George F. Milliken, of Boston.

(231) Heinrich Geissler, in Germany, constructs vacuum tubes.

(232) The Maine Telegraph Company's lines are leased to the American Telegraph Company, which company at the same time also takes over the management of the existing House lines between New York and Boston.

(233) Stark, of Vienna, Austria, and Bernstein, of Germany, experiment with diplex telegraph operation—two messages in one direction over a single wire.

(234) George M. Phelps, of Troy, N. Y., assists David E. Hughes in the development of an improved Hughes printer.

(235) Karl Frederick Gauss dies. (Born in Germany, 1777.)

**1856** (236) Aug. De La Rive, of the Academy of Sciences, Paris, publishes Volume 2 of his "Treatise on Electricity," a work of 912 pages. Volume 1 was published in 1853. This was one of the earliest complete textbooks on the subject of electrical science.

(237) George F. Green, a machinist of Kalamazoo, Mich., builds small electric cars and tracks to which electric power is supplied from primary batteries.

(238) Hiram Sibley, sheriff of Monroe County, New York, becomes (July 30) second president of the Western Union Telegraph Company. (He remained in this position until July 26, 1865.)

(239) The New York and Mississippi Valley Telegraph Company changes its name to Western Union Telegraph Company.

(240) Buff discovers that if a rod of aluminum is employed as one electrode in a saline electrolyte, current will pass through the electrolyte in one direction and not in the opposite direction.

(241) During the year the salaries of first-class telegraphers in the United States are $60.00 per month in large offices, and $50.00 per month in small offices. Chief operators receive $75.00 per month.

(242) A submarine cable is laid between Spezia, Italy and the Island of Corsica.

(243) Lieut. O. H. Berryman, U. S. N., sailing in the *Arctic,* and, independently, Commander Joseph Dayman, R. N., in H. M. S. *Cyclops,* make soundings in the Atlantic ocean between Europe and America.

(244) F. N. Gisborne lays a cable between St. John, Newfoundland, and Cape Breton (85 miles). This cable is stated to contain the first stranded conductor used.

**1857** (245) The Grenet "bottle" primary battery is introduced.

(246) The American Wire Gauge is introduced by J. R. Brown, of the Brown and Sharpe Company, succeeding, largely, the Birmingham Wire Gauge.

(247) Leon Scott invents the Phonautograph which records the vibrations of a movable membrane.

(248) Siemens, in Germany, makes an improvement in electric motors by inventing armatures with longitudinal windings.

(249) Steel is produced by the Bessemer process at Phillipsburg, N. J., from Sussex County iron.

(250) The first attempt is made to lay a submarine cable across the Atlantic ocean. The *Agamemnon* and the *Niagara* start from England on August 3 for Valencia Bay, Ireland, where the shore end of the cable is anchored. The plan was for the two ships to proceed westward together, each laden with one-half of the entire Atlantic cable; the *Niagara* to lay the first half while the *Agamemnon* splices the cable in her hold to that laid by the former ship, and continue on to Newfoundland. The start made from Valencia August 7. When the *Niagara* had laid out 380 miles of cable the latter broke and was lost in the sea with the exception of 50 miles of the shore-end, which later was picked up.

(251) Dr. Norvin Green arrives in New York and arranges a conference of the various presidents of existing telegraph companies, for the purpose of discussing consolidation.

(252) David E. Hughes, professor of music and physics at Beardstown College, Kentucky, granted a patent (September 23) covering his improved printing telegraph apparatus.

(253) Farmer and Woodman bring out an improved automatic telegraph repeater.

(254) The Western Union Telegraph Company pays its first dividend (December).

**1858** (255) The *Niagara* and *Agamemnon,* on May 29, commence cable-laying experiments in the Bay of Biscay for the purpose of perfecting cable-laying machinery to be employed in another attempt to lay a transatlantic cable.

(256) On June 10, both ships leave Plymouth, England, for a point in mid-Atlantic where the two halves of the cable are to be spliced; the *Niagara* proceeding toward America, while the *Agamemnon* proceeds toward England. The ships start on their opposite courses June 26, but the cable parted when but forty miles of cable had been laid. Both ships return to Ireland. A new start made July 17, the ships reaching rendezvous on July 28. This time each ship reached its final destination, and on August 5 the transatlantic cable was ready for test. After 400 messages had been exchanged between Europe and America (between August and September 18) the cable failed. The cost of the enterprise is said to have been $1,256,250.

*(To be continued)*

# Parasitic oscillations in broadcast transmitters

By A. D. RING

Senior Engineer, Federal Radio Commission

BY far the most difficult problem in the design and procurement of proper operation of broadcast transmitting equipment is the suppression of parasitic oscillations. Parasitic or spurious oscillation is defined as any frequency of oscillation generated by the transmitter removed from the fundamental frequency and which is not a true harmonic.

It is relatively a simple mathematical problem to calculate the correct values of inductances and capacities to operate at the fundamental frequency. Even the loading resistors. coupling inductances or capacities, etc., are not difficult to calculate, but when it comes to determining the ways and means by which the parasitic oscillations may be completely eliminated, there is no known mathematical or certain practical solution. There are, however, several known means by which the tendency for parasitic oscillations may be suppressed by inherent circuit design and by mechanical construction and arrangement.

The parasitic oscillations that are most difficult to control are those that develop with destructive force while the transmitter is apparently operating normally. This class of parasitics overloads the transmitter and generally the overload relays automatically remove the plate power, but upon being re-energized it again appears to work normally. This type is encountered mainly in high power transmitters. The next most difficult type to handle intereferes with the quality and fidelity of transmission without giving any other apparent or superficial symptoms. This type is common to all power transmitters. These are the two types that are most difficult to identify and eradicate. but there are several other known types.

In all, seven distinctive frequencies or bands of frequencies have been investigated wherein parasitic oscillations may develop in any broadcast transmitter using one or more stages of linear amplification. This group of seven bands of frequencies has each been definitely identified and the necessary steps to eliminate or reduce to negligible extent the spurious oscillations in any of these groups have been determined.

It is known that there are many broadcast transmitters now operating in a very unstable condition resulting in poor quality and low modulation due to some of the tendencies for parasitic oscillation having never been entirely suppressed. Any unsuppressed tendency for parasitic oscillation may seriously lessen the life of the vacuum tube and result in frequent arc-overs in the transmitter.

## All Transmitters Subject to Parasitic Oscillations

During the early stages of design of broadcast transmitters, it was thought that a series resistor in the grid circuit of the tube was a panacea for all such difficulties, but with the coming of high power and voltage linear amplification, these devices often prove more disadvantageous than beneficial. Other means of controlling parasitic oscillation had to be developed and to do this it was necessary to make extended study and identify each of the classes of parasites encountered. As far as known, all transmitters are subject to this weakness, even short-wave transmitters using one or more tubes often require many days of test and study to eliminate successfully all tendencies for parasitic oscillations. Seldom is it found that these oscillations are sustained, but when such a case is encountered it ordinarily requires no more than the application of simple and well-known engineering principles to eradicate them. It is those parasitic or spurious oscillations that appear for only an instant with destructive force and then disappear that are the source of the great difficulties.

Fig. 1 shows a typical broadcast power linear amplifier stage using four tubes in a push-pull circuit, two on each side. The plate power supply for this stage is from a rectifier. The grid bias supply is a motor generator set. To begin with, this amplifier stage is designed to have maximum inherent discrimination against parasitic oscillation. This is accomplished in part by inserting the shunt condensers C6 and C7 directly between the grids of the tubes and the filaments. These condensers have a certain reactance to the fundamental and are calculated so as to operate properly in the fundamental circuit, but for all parasitic oscillations of higher frequency than the fundamental they have a lower reactance and, therefore, load the parasitic circuit. In addition to these capacitors, the resistors R1 and R2 are shunted from the grid to the filament directly, first to improve the regulation of the grid circuit of the linear amplifier stage so that the positive modulation will not be distorted during the times the grids are positive and. second, to add a resistor load for parasitic oscillations. The values of these resistors are calculated from the amount of power that it is desired to dissipate from the preceding stage and the voltage that will be across them when the grids of the linear stage are operated at about half saturation which is the correct excitation for normal carrier and the allowance for 100 per cent modulation.

The tank condenser is composed of condensers C8 and C9 grounded in the center so as further to act as a low impedance shunt for parasitic, spurious and harmonic oscillations. The seven groups of frequencies in which parasitic oscillation may develop are discussed herein beginning with the lowest frequency.

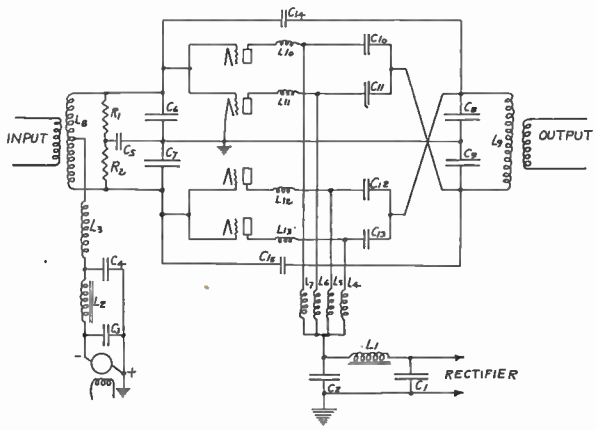


Fig. 1. Power linear amplifier stage.

### Dynatronic Band of Frequencies

The first band of frequencies in which parasitic oscillations may exist in the linear amplifier extends from approximately one quarter to five cycles per second. This band has been arbitrarily designated by the writer as the dynatronic band and the frequency is determined by the natural frequency of the filter circuit on the power supply C2, C1, and L1.

Fig. 2 shows a typical saturation curve of a linear amplifier. The r-f. grid voltage is plotted as abscissa against plate current, tank current and antenna current as ordinate. The plate voltage and grid bias voltage are constant. At point A this curve departs from a straight line and this departure lessens until point B is reached where the characteristics again become substantially linear. This is due to the dynatronic characteristics of the grids of the tubes in the amplifier and occurs at a point just before the grids are driven positive during the radio cycle. If the excitation on the grids of the linear amplifier stage is such that the tubes are operated at this point without modulation, sustained oscillations may be set up in the output with a frequency of from one-quarter to five cycles per second. This oscillation finds its existence in the plate power supply filter circuit which form the tank C2, C1, and L1. The complementary grid bias filter forms the tank C3, C4 and L2 which assists this oscillation but if this tank is entirely eliminated, the oscillation may not be suppressed or materially affected. This is a characteristic of the typical dynatronic oscillator. The best cure for this is to change the degree of excitation so that the peak r-f. grid voltage is either above or below this region AB (Fig. 2) and the oscillation will be entirely suppressed. The sharpness, width and purity of this oscillation is dependent to a great extent upon the dynatronic characteristics of the tube. The d-c. current bias and radio-frequency excitation act as a holding bias to establish a reasonably good dynatronic oscillator with the filter on the plate power supply acting as the oscillatory circuit.

If the vacuum tubes have bad dynatronic action, the only solution is to operate the amplifier so that the peak r-f. grid voltage during no modulation is not in this region. Another general cure for the troubles caused by poor grid characteristics will be discussed later. The mu of the vacuum tube determines where this region AB falls, if the load and plate voltage are fixed. On a high-mu tube this area is generally below the carrier operating point and on very low-mu tubes it may be above the carrier operating point. On a medium-mu tube it may fall in the operating region and give untold troubles before being discovered. This is one of the major disadvantages of low- or medium-mu tubes as linear amplifiers.

### Second Band

The second band of frequencies is generally one-third to one-fifth the frequency of the fundamental. This oscillation is caused and determined by the plate chokes L7, L6, L5, and L4 combining with the plate blocking condensers and tank condensers C10, C11, C12, and C13 forming a new tank circuit into which the tubes operate. This plate tank circuit is duplicated in the grid circuit of the tube by L3, C6, and C7 forming a comparable grid tank. This circuit operates with all tubes in parallel throughout so that the neutralizing condensers (C14 and C15) assist the oscillator rather than neutralize the feedback. Fig. 3 shows the fundamental circuit of this parasitic oscillation in conventional schematic arrangement. The circuit of Fig. 3 A is identical to that of Fig. 2 but drawn to better show the parasitic tanks, (Fig. 3). B is simplified to show just one tube and the inductances and capacitors are combined into one where possible. The circuits that do not enter into the fundamental of this parasitic circuit are omitted. This oscillation is often very annoying when it is not known to be present and frequently the engineer testing the transmitter overlooks this band in testing for parasites and accordingly many tubes and condensers may be ruined. After once being identified this oscillation can be eradicated very easily by changing the value either of the grid tank or the plate tank described so as not to have sufficient near resonant characteristics to cause oscillations under any conditions. The addition of the capacitor C16 (Fig. 3 A) will accomplish this without affecting the fundamental circuit, if sufficiently large in capacity.

It has been found empirically that it is generally better for the purpose of suppressing spurious oscillations of any frequency to tune the grid circuit to a higher frequency than the plate tank circuit. If long grid leads must be used, artificial inductive loading should be inserted in the plate leads so as to make the natural period of the undesired plate tank circuit to be more than that of the undesired grid tank.

This band of parasitic oscillations caused by the plate choke and plate blocking condensers forming a tank complementary with the grid choke and condensers, can generally be detected by removing the excitation and reducing the bias on the stage being tested, with medium plate voltage, until the tubes begin drawing plate current, then excite the tubes with a little fundamental excitation and remove quickly. Under these conditions the tubes will continue to oscillate as determined by the above tanks at very low efficiency, depending upon the degree of resonance between the plate and grid tanks. The frequency may then be measured by a wavemeter.

### Difficulties at Fundamental Frequency

The third group of frequencies at which parasitic oscillation may develop is around the fundamental operating frequency. Nothing need be said in this article as to the control of them as any well-designed circuit will not be subject to fundamental frequency oscillations other than those determined by the application of external excitation. Before the days of neutralization, these were the problems. However, the advent of neutralization has successfully eliminated such troubles except in a few remote cases where the tank inductance and grid inductance are too closely coupled or some similar allied points of poor mechanical design exist.

The next band or fourth group of frequencies in which parasitic oscillations may be encountered is in the order of four to fifteen times the fundamental frequency and is determined by the direct grid and plate leads to the tubes. That is, the leads from the grid of the tubes to the condensers C6 and C7 form a short tank circuit with the various distributed capacities. The fundamental inductances and capacitors may affect the frequency of oscillation somewhat but do not enter into this parasitic circuit as an essential part thereof. The similar leads from the plates of the tubes to the condensers C8 and C9 form a comparable tank in the plate circuit.

This band of frequencies is never sustained and can usually be detected only by drastic tests, the commonest of these is accomplished by coupling several wavemeters which are tuned throughout this parasitic band to the tank of the transmitter and supplying maximum power to the transmitter and subjecting it to severe transients. Then

| NUMBER OF RADIO RECEIVING SETS NOW IN USE | |
|---|---|
| United States | 16,679,253 |
| Canada | 571,898 |
| Mexico | 100,000 |
| Cuba | 35,000 |
| Porto Rico | 5,000 |
| Newfoundland and Labrador | 2,024 |
| Alaska | 1,500 |
| Dominican Republic | 1,300 |
| Salvador | 1,000 |
| Costa Rica | 1,000 |

inspect the wavemeters, the one or more blown out will be the ones tuned nearest to the frequency of this particular parasitic oscillation. If none are burned out after several trials, there most likely is no trouble from parasites in this band. This spurious oscillation, if found to be present and identified, may best be controlled by adding small inductances in the plate lead (L10, L11, L12, and L13) of each tube immediately adjoining the plate so as to tune this distributed plate tank as described to a much lower frequency than the comparable grid tank.

Low resistance resistors are often shunted across these inductances so as to load the high frequency spurious oscillations in a proper manner. These loading coils (inductances) and resistors also help ameliorate another band of parasitic oscillations.

The fifth and next highest band of frequencies in which parasitic oscillations occur varies rather widely and is caused by the two tubes in parallel on one side of the push-pull amplifier developing push-pull oscillations between themselves. These parasitic oscillations may become extremely severe and develop tremendous voltages. At times, arcs as much as one foot to eighteen inches long may be drawn from the plates of the tubes to a very small space condenser (approximate capacity 0.000001 mfd.) while operating with a plate voltage of 18000 volts. The fireworks and pyrotechnical displays possible through this particular spurious oscillation are astounding.

## Remedy

The remedy lies in adding small loading inductances directly in the plate lead so as to tune this plate tank to a lower frequency than the comparable grid tank. These same loading inductances (L10, L11, L12, and L13) are used to suppress another band of parasitic oscillations as outlined in the fourth group. The mechanical construction and arrangement of the component parts of the fundamental circuit are also very important in controlling this class of spurious oscillations. Experience is the best teacher in this regard and few helpful suggestions can be given by the writer except to suggest that the grid leads must be kept as short as possible. This is the main electrical consideration to be kept in mind in making the mechanical design of the transmitter.

It is usually the practice to mount the cases of the condensers C6 and C7 on the filament buss and the grid chucks on the bells of these condensers. Unless the grid to the filament path is kept this short there is sure to be one or more parasitic oscillations present under conditions favorable to them. Resistors

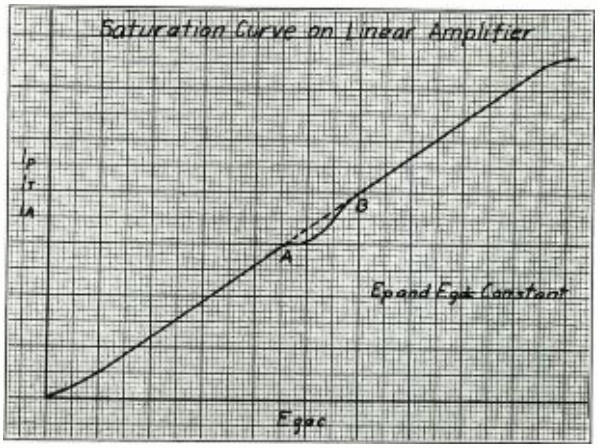


Fig. 2. Saturation curve of linear amplifier.

directly in series with the grid leads, is the type of suppression arrangement formerly used but with the advent of the high power linear amplifier they become entirely inadequate and give rise to other complications and so are now never used in a well-designed linear amplifier. They may be used with success in grid saturated (Class C) amplifiers using more than one tube. For high power work, it is almost impossible to obtain these series resistors for the grid leads that do not have considerable inductance and distributed capacity. This may be the cause of the ineffectiveness and disadvantage for high power work but fundamentally there are also other disadvantages.

## Oscillations Unidentified

The sixth band of parasitic oscillations has a frequency in the order of from 30 to 300 megacycles. This band has never been positively and definitely identified by the writer as to the cause but it seems that these oscillations are caused by the internal grid leads and grid structure within the tubes themselves, especially when the leads are long such as encountered in large vacuum tubes. If oscillations develop in this band, it will be revealed by the transmitter "kicking" off the air by overloading without any apparent improper functioning of the tubes or circuits. The writer has facetiously termed this band of oscillations "kicks." (The meaning here, however, is entirely different from that of the same term as used in radio allocation engineering.) Practically all of the parasitic oscillations that are not sustained are caused by the erratic grid characteristics of the tubes. This is especially true of the first, sixth and seventh groups. These "kicks" may develop and occur only once in long periods and again they may become very frequent, acting very similar to the arc-backs in mercury vapor rectifier tubes. These parasitic oscillations may be distinguished from others that overload the power supply by the extreme rapidity of action. They act as if a direct short circuit were instantly connected between the plate and filament of the tube. No external effects of any kind are ordinarily seen.

Certain of the other groups of parasitic oscillations also overload the transmitter but analyzed with an oscillograph they will appear much slower in operating than the "kicks." These "kicks" may really not be oscillations at all but an extreme decrease in the impedance of the tube caused by gas liberation. The solution appears to lie in making the fundamental circuits as stable as possible and accepting only those tubes that do not give this trouble in the stable circuits. These "kicks" may be caused by a condition of local action that is set up in the grid itself due to its mechanical construction or impure or spurious materials but little is known along this line except that the better the tubes are the less are the "kicks" that develop.

The writer has suggested that a condenser could be inserted at the extreme end of the tube structure between the grid and filament to load this parasite. Such a condenser could load the fundamental circuit thereby increasing the r-f. grid current and possibly causing an appreciable potential gradient along the grid due to the current in the condenser and the inductive reactance of the grid structure. This is undesirable and may be prohibitive for high frequency operation.

## The Harmonic Group

The seventh band of frequencies in which parasitic oscillations may develop is termed the harmonic group and is generally caused by the spurious and erratic emission from the grid. The frequency of this harmonic group is generally a fractional harmonic of the fundamental such as three-halves, four-thirds or five-fourths or multiples thereof. Practically all parasitic oscil-

lations are accentuated by poor and erratic grid characteristics. This fractional harmonic group, however, seems to be present only where tubes of extremely erratic grid control are employed. The grid may have had secondary (dynatronic) emission or primary emission. This band of frequencies generally is sustained after the transmitter has warmed up, and may be detected by placing a wavemeter close to the tank inductance and tuning throughout the band. The control and suppression of this parasitic oscillation depends first upon procuring an inherently stable fundamental circuit with suppression of all other parasites and then connect a rectifier tube from the grid to the filament of the power tubes in extreme cases.

This rectifier tube is connected with its plate to the grid and its filament to the filament of the power tube. If the power tubes were functioning properly, this rectifier tube would merely add an additional load to the grid circuit in parallel with R1 and R2 when the grids are driven positive with respect to the filaments. This type of load is quite undesirable in the ideal case and counteracts the beneficial effects of the load of R1 and R2 so far as a regulation for improvement of positive modulation is concerned.

In the practical case, however, with power tubes of bad primary and secondary grid emission, the grids unload themselves when driven positive and tend to be self-exciting giving rise to parasitic oscillation. The action of the rectifier tubes counteracts this unloading and thereby prevents the self-excitation on parasitic frequencies. As a whole, rectifier tubes tend to suppress all spurious oscillations caused by poor grid characteristics in the positive region. The impedance of the rectifier tube should, of course, be such as to give the required complementary load for the particular power tubes used.

All of the parasitic oscillations higher in frequency than the fundamental are interrelated. The general remedy applies to all these groups but after the general remedies have been applied, it is usually necessary to investigate and treat the groups individually. Tubes of the same type number and power rating and superficially identical may vary materially in erratic grid charactertistic.

There is one general test for parasitic oscillations and unstable conditions in broadcast transmitters that may be made without any special equipment and is quite informative. This test consists of tuning a monitoring receiver to the output of the transmitter and increasing the gain on the receiver as high as possible without saturating it. The transmitter is then varied from very low excitation to high excitation by a smooth control while listening to the loudspeaker of the monitor and carefully observing the pointers on the plate ammeters on each linear stage. If any of the pointers are seen to jump, or vary not in exact accord with smooth excitation, or any kind of squeal or heterodyne is heard in the loudspeaker, even faintly, there are some parasitic or unstable conditions present in the transmitter.

The smooth control of the excitation may best be accomplished by detuning the tank circuit of the second buffer stage following the crystal oscillator so as to reduce its output power to practically zero and to increase it to the full amount. If this tank tuning is done by means of a continuously variable condenser, a smooth control may be had over the excitation on each linear amplifier stage. Adjust this control to several degrees of excitation by regular steps and at each oscillate the control rapidly through a small arc and observe if all the plate ammeter needles vary exactly in accord therewith. If not, there is some unstable or parasitic condition present.

It would be well before concluding this test to shunt out the plate resistor in series with the modulated amplifier and, if possible, increase the grid excitation of the first linear stage by increasing the coupling so that all linear stages may be fully saturated at maximum excitation and then by means of this tuning control each stage may be operated from zero to excitation to saturation.

The conditions for dynatronic oscillations as outlined in Group 1 will be passed on all tubes during this test and the results therefrom may be noted in an oscillograph if available. If not, some special means for detecting a one-quarter to five-cycle frequency must be employed. If mercury vapor rectifier tubes are used in the plate power supply, they will indicate this oscillation, if intense, by flickering in accordance therewith. The parasitic oscillations that cause the plate ammeters to jump slightly or cause the heterodynes in the loudspeaker are generally of the higher order of frequencies and upon being detected by this method must be determined individually as set out under the discussion of each group so that the proper procedure for eradication can be followed.

In constructing a broadcast transmitter using linear amplifiers great care should be taken to design the fundamental circuits so as to discriminate inherently against each of these groups of parasites, then make the mechanical construction and arrangement such that the maximum possible inherent suppression may be had of the spurious oscillations. When the equipment is built and on test, carefully investigate each band to determine that the transmitter is stable with respect thereto. If these tests prove that the transmitter has no tendency whatsoever to oscillate in any of these bands, one can rest assured that the "sweet" quality heard from certain broadcast stations may be obtained. Far more objectionable and disagreeable distortion is caused by amplitude distortion associated with parasitic tendencies than by the transmitter not being flat from 100 to 5000 cycles to within 4 decibels.

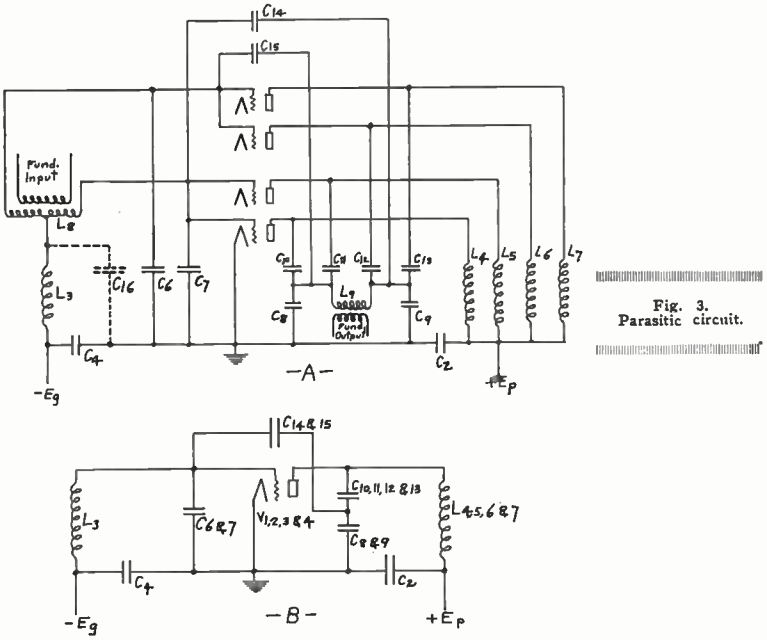


Fig. 3. Parasitic circuit.

# Testing radio receivers on the assembly line

By Arthur E. Thiessen*

THERE is no other single test that will give the figure of merit of a radio receiver more accurately than the measurement of its overall sensitivity. Because it is one of the fundamental characteristics of any receiver, laboratory information on the sensitivity is usually well known. A quick comparison of the sensitivity of the sets as they progress along the final inspection line with the predetermined laboratory standards has proved to be a most satisfactory indication that their performance is acceptable.

It is almost always necessary to align the ganged variable condensers in a receiver during the final testing operation and a good radio-frequency oscillator is required for this. For superheterodynes, the alignment process must be made at frequencies both in the broadcast band and at the intermediate frequency. Since sensitivity tests must also be made. the standard-signal generator is often used as the aligning oscillator.

The General Radio Type 601-A standard-signal generator has proved to be a most useful instrument for these tests.

In order to take care of the peak production from this plant, ten test positions are necessary. Each one has its Type 601-A standard-signal generator mounted upon a cabinet containing two loudspeakers (one is a standby in case of trouble) and an output meter. The completely assembled chassis are received in the test room from the slowly moving conveyer which has carried them down from the assembly departments. The power and loudspeaker leads are plugged in and the radio-frequency input from the standard-signal generator, working through a standard dummy antenna, is connected to the proper terminals.

Each standard-signal generator has two oscillator coils, one for the intermediate frequency and one for the broadcast band, either of which may be selected by a switch on the panel. While working at the low frequency, the intermediate-frequency system of the receiver is lined up. After this adjustment the generator is switched to the high frequency and the general lineup of the receiver is made.

The next step is to determine the overall sensitivity at several points in the broadcast band. These test frequencies are indicated by lines on the main tuning dial. The generator is set step-by-step to each of these frequencies, the receiver tuned to them one at a time, and the sensitivity of the receiver measured in the usual way by observing the audio-frequency output for a given signal input.

Standard output is marked on the output meter and above it is the meter and multiplier of the standard-signal generator showing microvolts input. In this way, the operator has the whole story before him. At times, he records his observations on the charts provided and these are most useful to the production supervisor.

As a final check, a loudspeaker is turned on for a listening test.

Although the tests were originally designed for broadcast-receiver measurements, sets intended for operation at the police or aircraft frequencies could also be quickly checked by changing the coils of the standard-signal generators.

After some experimentation, toroidal coils were selected instead of solenoids because, although a little more difficult to build, they have so little external field that shielding is much simplified.

The radio-frequency amplitude is measured by means of a vacuum-tube voltmeter. This is a tube operating in the usual way by observing the incremental change in plate current due to changing amplitudes of radio-frequency voltage on its grid. The direct current is read by means of the microammeter on a panel. All of the radio-frequency circuits except attenuator are located on a shelf and are covered by a shield.

Fastened to the under side of the shelf is the audio-frequency modulator circuit. It is a standard tuned-plate oscillator operating at 400 cycles per second with an amplitude sufficient to provide modulation at either 30 or 50 per cent. Normally, the Type 601-A standard-signal generator is supplied with 30 per cent modulation, but if desired adjustments necessary for 50 per cent modulation can be made before the instrument is shipped.

The toroidal oscillator coil is tapped and a small part of the total voltage across it is led off through a shielded conductor to the attenuator. A casting in back of the modulator circuit of the panel houses the complete attenuator assembly. It is divided into three separate compartments between which the attenuation units are divided so that the total voltage reduction in each does not exceed 40 decibels. Due to stray admittances, it is virtually impossible to exceed this attenuation within one shield without encountering serious errors.

The whole attenuator assembly is in contact with the front panel at only one point—where the low-voltage output jack is located. This helps to reduce circulating panel currents to a

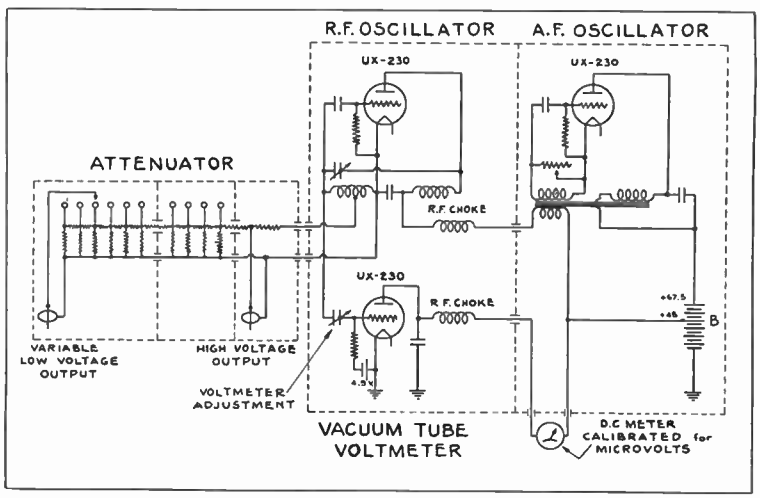


Fig. 1. Schematic wiring diagram for a type 601-A standard-signal generator.

* *Engineer, General Radio Company.*

point where they do not affect the measurements at high frequencies to any extent. The output voltage lead to the receiver under test is shielded and enters the attenuator through a plug and jack construction that maintains the continuity of the shield directly to the attenuator circuit.

Two output jacks are provided, one connected to the variable voltage output and the other to a fixed point on the attenuator system at a higher voltage. The former provides outputs variable in steps from 1 to 20,000 microvolts. The fixed tap is at 100,000 microvolts. All of these ranges can be multiplied by a factor of 1.5 by increasing the radio-frequency oscillator amplitude to the correct point as indicated by the vacuum-tube voltmeter.

Reference to the schematic wiring diagram shown in Fig. 1 will indicate the arrangement of the circuit elements.

As will be noted, the modulation voltage is introduced in series with the plate-supply battery of the radio-frequency oscillator. With this method of modulation, it is necessary to provide a highly stable high-frequency oscillator, otherwise difficulty is encountered due to frequency modulation. That is, the plate voltage applied to the radio-frequency oscillator tube, varying at an audio rate, may shift the carrier frequency by a considerable amount unless the most stable high-frequency oscillator circuits are used.

The vacuum-tube voltmeter is connected across one-half of the oscillator coil in series with a very small variable condenser, which is used to adjust the reading of the voltmeter. The attenuator voltage is taken across a part of the coil.

Only one of the two radio-frequency oscillator coils is shown in the diagram for the sake of simplification. The switching between these coils is arranged so that the one that is not operating is completely detuned by shunting a large condenser across it. Thus, no reaction can occur between it and the coil in use.

In order to provide a means for checking the voltages of the various batteries without a multiplicity of meters, the microammeter is connected to a multi-point switch with suitable series resistors for making direct-current-voltage measurements on the A and B batteries.—*From G. R. Experiments, April,* 1932.

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# The Peck television system

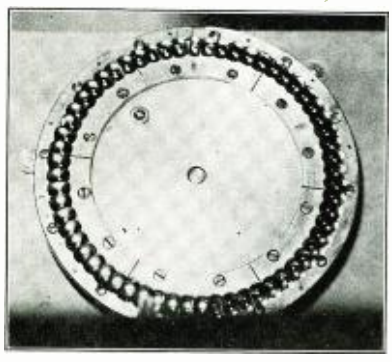
THE Peck system of television which is now being demonstrated in New York, has attracted considerable attention from engineers. William H. Peck (of former moving picture apparatus activities) is the inventor. He has three applications in the patent office covering his system.

The novel thing about the system is that reflecting spherical lenses are used to reflect the beam from a condensing lens system to a ground glass or a special screen made up of a light weight material and waxed. The image is thrown on the rear of the screen. The size of the normal closeup picture is 10 inches by 14 inches and on ground glass is very good. By removing this screen and holding up a, say, three by four foot screen at a considerable distance from the scanner, one is able to see a large picture, with of course much less illumination because of the diffusion of the already low output crater type neon. This particular lamp used during the demonstration was made by Eveready and had a normal current of 40 ma. at 200 volts. It was used in conjunction with a pair of 245's in parallel.

In brief, the scanner consists of a 1,200 r.p.m. synchronous motor whose shaft position in the cabinet is slightly off the horizontal, and on one shaft projection is mounted a substantial wheel or disc having a total of 60 spherical lenses mounted on the outer face of the wheel at the periphery. These lenses are carefully ground to accuracy and are so placed as to give full sixty-line scanning in the vertical with one complete revolution of the wheel. At a speed of 1,200 r.p.m. there are naturally twenty frames per second. The reflecting lenses are not spheres, but are half-spheres with the flat portion silvered. The crater lamp used has at 25 mil. opening, which is stopped down in the condensing lens system to 20 mils. The condenser lens is mounted above and in front of the scanning wheel and throws a concentrated beam derived from the neon light source on the reflecting semi-spherical lenses, which project a straight beam to the screen. The remarkable result is that there are no horizontal lines generally found in motor driven disc scanners such as the Nipkow or modifications employing lenses mounted directly in the disc. Neither is there the hunting effect one generally sees in these types of discs, or the flicker so apparent even at 20 frames per second in poor television reproduction.

The important feature of the device is the novel optical system, which is a modification of the Coddington spherical lenses. It is stated that Mr. Peck contemplates setting up a 180-line transmitter for direct connection with a 180-line scanner to show what may be done with increased lines. There is no doubt about the improvement possible, *but* what would happen to the available channels for elevision if a further increase is made, and if every picture transmitting station adopted the same specification? Of course, there is a reasonable value of lines which will give a good picture. Perfection of detail is not necessary, but sufficient lines are required to give a large picture commensurate with good home moving pictures. It is believed that 180 lines will do an excellent job, for with a picture say three by four feet one would have to get away ten to fifteen feet to properly view it, and then the one hundred eighty lines would merge into a solid picture.

At the moment, an element in the Peck system is that there is difficulty in getting sufficient light intensity, even in a dark room, to show a large picture, say 3 feet by 4 feet. The small picture on ground glass is very good and is better than many commercial scanners.



The reflecting lens scanning disc used in the Peck television receiver. A picture 12 inches wide is secured at 12 inches from the disc.

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## T. F. JOYCE SUCCEEDS J. W. McIVER WITH RADIOTRON

J. W. McIver has resigned his position as sales promotion and advertising manager of RCA Radiotron Company, Inc., and E. T. Cunningham, Inc., to accept the post of executive vice president of the Forbes Lithograph Company, Boston.

T. F. Joyce, long associated with Mr. McIver in the Radiotron Company and the Edison Lamp Works, has been appointed advertising and sales promotion manager of Radiotron and Cunningham.

# Remote control of broadcast programs†

By GEORGE W. HAUG

IN the realm of radio broadcasting the work of the technical engineers and operators is rarely considered by the radio audience. Inquiry reveals that in a radio broadcast the greatest responsibilities lie on the chief engineer, operator, and frequently the remote control operator.

A remote control operator is a person whose existence is unsuspected by the public, but whose duties are actually more important than those of an announcer or an artist. All that the unknowing expect of a remote control operator is that he get to his job on time and that he turn on an amplifier. Though it is not laborious work, it is the position where the equipment must be maintained in operative condition, the place where good judgment is imperative, as the entire broadcast is dependent upon this.

### Program from Remote Point

When the station manager decides to put on a remote program, the first step is to get a telephone line to the point of broadcast. The most frequently used remote studios have permanently erected phone lines to the amplifier. This sounds easy, but is in itself a result of considerable planning and careful consideration of the chief radio engineer. When there is no permanent telephone line available, the next job for the remote control operator is to erect a circuit to the nearest telephone line. It is quite necessary for such line to be dependable and inexpensive.

It is nearly always possible to use the broadcast line for communication before the broadcast begins, and sometimes it is possible to have another line for communication, but when this would involve running another line or renting a long distance circuit some other method must be used. In this case a high frequency buzzer used in a phantom circuit is the best solution. Communication may then be carried on with code without interfering with the broadcast. The arrangement of this circuit is shown in Fig. 1.

The buzzer, battery, and potentiometer may be mounted in a substantial cigar box, with a key on top to make a portable outfit. By balancing the signal on the broadcast line with the potentiometer, this serves as one side of the communication line and the ground is used as the other side. When perfectly balanced by the potentiometer the buzzer will not interfere with the broadcast unless it is picked up in the microphone. A similar arrangement is used at the station. A vacuum tube audio-frequency oscillator may be used instead of a buzzer and the danger of picking up the signal in the mike will be eliminated. Such a communication system has proven very valuable during broadcasts and is almost indispensable.

After a line is completed and tested and the time for the program approaches, the amplifier and microphones must be set up to provide the best possible pickup and control of the program. To get a good broadcast from the average building is much more difficult than in the main studio. The location of the microphone and the source of sound is a difficult problem when good tone quality is desired. It is necessary for the remote control operator to use his best judgment from the knowledge he has of sound and wave propagation and then to consult other sources of reliable information on the problem to insure the best possible arrangements. With these definite arrangements in mind he makes the various tests with the station operator.

After using the greatest possible care in the construction, arrangement, and choice of other equipment, it is logical for a good remote control operator to use the most convenient and efficient portable speech amplifier that is available. There are many different makes, sizes and shapes of portable speech amplifiers on the market, as nearly every radio manufacturer builds some kind of an amplifier to complete their stock. On account of the cost, and the fact that they are not easily portable, because of the external batteries, many radio stations build their own to suit the requirements.

### The Bility Amplifier

An amplifier that is well worthy of the name, "The Bility amplifier," because of its portability, flexibility, and dependability will be described in this paper together with a diagrammatic arrangement as shown in Fig. 2.

This is undoubtedly an efficient amplifier, containing only the essential apparatus. Its completeness from an engineering viewpoint, along with its simplicity of operation and adaptability to nearly any type of broadcast make it quite outstanding. The most noteworthy feature in regards to adaptability is the use of two microphone circuits which permit complete control of either or both mikes with no effect on the impedance of the circuit. These controls serve both for mixing and volume control. Switches in the microphone circuits are by-passed with fairly large condensers to slow the sudden change of current which exists on breaking the circuit, preventing it from "packing" the carbon microphones. A fixed dropping resistor is used to give the proper microphone current. A jack is placed in the lead to each microphone button so that the currents may be checked to see if they are balanced.

This is a decided advantage over a reading of the total mike current, because it checks the condition of the microphone as well and it is necessary to have the currents well balanced for good quality. A fixed resistor is placed in the grid bias lead of each stage to insure stable operation. The ground return in the grid circuit of each stage is then by-passed to the ground by a condenser large enough to pass all audio-frequency currents. The battery side of the primary winding of the interstage coupling transformer is also by-passed with a fair sized condenser to furnish a direct return for the audio-frequency currents. Double pole, double throw snap switches are used in the plate and filament circuits so that external batteries may be connected in case of an emergency or on a long broadcast.

### The Panel

The system of jacks in the filament and plate leads to each tube, together with a milliammeter, cord and plug, are mounted on the panel for the purpose of an instantaneous check on all circuits of the amplifier. One meter is essen-

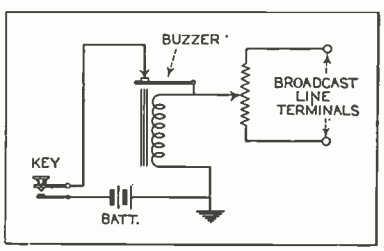


Fig. 1. Signaling circuit.

†*Prize paper presented at A.I.E.E. students' conference.*

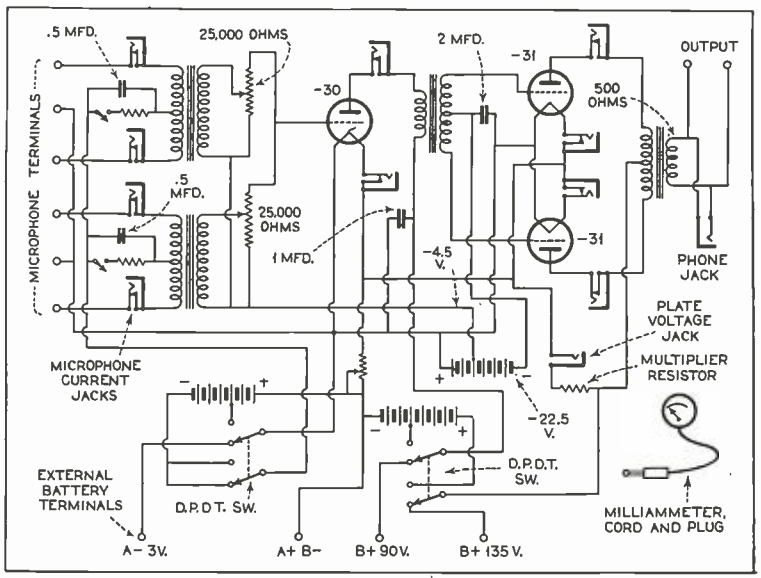


Fig. 2. Bility amplifier circuits.

tial and may easily be made to serve all requirements. The majority of portable amplifiers on the market either do not have meters, or are decorated with two or more, which is added weight without added convenience. An open circuit jack in series with a multiplier resistor across the plate supply will permit plate voltage readings to be obtained as some multiple of the milliammeter reading.

The most desirable tubes are: a type 230 in the first stage and two type 231 tubes in push-pull in the second stage. These tubes are less microphonic than the type 201A tubes ordinarily used and require only a small filament voltage and current permitting the use of dry-cell filament batteries with economy. They furnish all the gain that is required with quality equally as good as any other type of tube.

The amplifier is built with a self-contained battery supply of dry cells for the filament and microphone, and small sized B batteries for the plate and grid supplies. The complete outfit can be arranged systematically and compactly, weighing approximately fifty pounds, which is about the weight of one filament battery for the average amplifier. The Bility amplifier is extremely convenient, easy to handle, and is capable of satisfying all requirements for remote control programs with such smoothness of operation as affords a minimum of interference.

### Interruptions

In spite of the fact that judgment, and the best equipment available are used there may be occasional disturbances in the programs. It is possible for a disturbance to appear to be in the microphone circuits which would call for the remote control operator to remedy it even though he is not dressed for the occasion. In fact the mike is quite likely to be in perfect condition, as the trouble may be due to other causes. An X-ray machine in a doctor's office could cause interference, and may at times be difficult to stop. The violet-ray machine which is used in homes and beauty parlors is also a source of pronounced interference. It might be that the paint which was used to insulate the microphone terminals from the ground has broken down and caused sputtering. Some manufacturers should use better paint.

When using amplifiers near storage batteries, care must be taken to keep the acid and fumes away from all wires, except the battery leads, and special care taken to keep the acid off the microphone cords as it will pass current between the leads and set up a disturbance which is difficult to locate.

In the selection of microphones there are several factors to consider. To broadcast some musical programs, such as classical organ music when played softly, and on the majority of public addresses, a condenser microphone is needed. Its cost and bulkiness limit its use, and for other purposes in remote control work a carbon microphone is much more convenient. The new dynamic microphone, which consists of a coil in the field of a permanent magnet and attached to the diaphragm, seems to be the answer to the prayers of remote control operators. Its output is less than that of a carbon microphone but is greater than that of a condenser microphone. Its impedance is low compared to a condenser microphone. For this reason it may be placed at a considerable distance from the amplifier while a condenser microphone must have an associated amplifier. It does not require any battery current for its operation and should stand much rougher handling without impairing quality, than a carbon microphone will.

Because of the fact that it does not require other current suggests great possibilities of building a light, portable amplifier that is operated on alternating current.

When using an amplifier with provision for the use of only one microphone circuit at a time, as is available on the market, it is frequently necessary to use a mixing panel. Fig. 3 is a diagrammatic arrangement of a mixing panel which accommodates three microphones.

By using microphone transformers with low impedance secondaries and constant impedance volume controls of the same value, the three circuits may be connected in series so the total impedance will equal that of the input of the amplifier to which it is connected and the microphone current may be gotten from the amplifier battery supply. With this arrangement either or all microphones may be controlled without changing the total impedance of the circuit. This convenience can hardly be over-emphasized when it is necessary to switch from one microphone to another during a broadcast, or when it is necessary to blend music and voices. With some experience and skill a good blend may be obtained which would be quite difficult with only one microphone.

Remote control work is sometimes exciting, especially when unexpected troubles occur. It is interesting because of the continual arising of improvements and the programs are nearly always entertaining or instructive.

The main objective of the remote control operator, which he inherits from the station operator, is to control all programs so that the radio audience will be unaware of his existence.

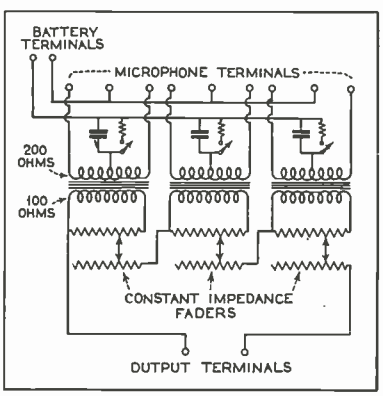


Fig. 3. Mixing panel for three microphones.

# Onward march of short-wave radio

RADIO entertainment in the new short-wave receiving sets, their wider sphere and also limitations, and information for the radio public for their best operating results, are detailed in a statement just issued by the Radio Manufacturers Association, Inc., comprising virtually all prominent radio producers. The statement was prepared by the Association's engineering division, approved by its board of directors, and deplores exaggerated advertising claims for the new short-wave receivers, while pointing out their wide field of new radio entertainment and service.

The statement of the RMA, to give the radio public and industry authoritative and actual facts regarding radio development, follows similar informative statements from the Association on television experimentation, and other new radio progress from radio laboratories. The statement on short-wave reception follows:

### Short-Wave Reception

"The importance of short-wave reception in the past year is demonstrated by the wide interest shown in commercial short-wave receivers, the acceptance by the public and the dealer of a well designed and engineered short-wave product, and the appeal which short-wave reception has to the user, especially when reception direct from foreign countries is possible.

"Unfortunately, however, very exaggerated advertising claims have been made regarding reception on short waves. Reception from stations in London, Paris, Berlin, Africa, Honolulu, Cuba, South America and other distant points, has been almost guaranteed at any time of the day or night with perfect clarity and fidelity. Thus. the misguided public is led to many disappointments when one of these short-wave receivers is purchased.

"This statement is intended to make clear just what can be expected in short-wave reception with receivers properly engineered and designed.

"The term 'short waves' is used to indicate wavelengths shorter than those employed in the standard broadcast band—that is, below 200 meters. Short-wave reception at present includes wavelengths down to about 15 meters.

"The transmission and reception of short waves have been studied by the most brilliant engineering minds in the world. Many of its phenomenal characteristics are very well known and much has been accomplished in obtaining reliable and dependable broadcasting in the short-wave band. Successful trans-oceanic telephony on short waves is well known to everyone and re-broadcasting of short waves from foreign stations on elaborate national broadcasting networks has passed beyond the stage of engineering achievement and is taken as a matter of fact by the public. These systems, however, have been developed with considerations given only to service and dependability and to obtain these two important requisites the cost of the associated apparatus has run into considerable sums of money, notwithstanding the time and cost for engineering research and development of the systems. Even with these elaborate and expensive systems service on short waves has been interrupted by atmospheric disturbances and other factors beyond the control of the systems used.

In commercial short-wave reception, in which entertainment must be afforded, the problem is to design a receiver capable of satisfactory reception. Unusual and miraculous performance can be expected of this type of receiver no more than with a well designed broadcasting receiver. No one in New York with a standard superheterodyne broadcast receiver would expect to receive a station from Los Angeles, California, consistently, although the receiver may be perfectly capable of this reception under favorable conditions and yet many users of short-wave receivers expect 'round the world reception every day, in all seasons. The cost of short-wave receiving equipment increases at a greater ratio with improvement in operating characteristics than the cost of regular broadcast equipment.

"Many factors influence the transmission and reception of short waves. Daytime reception is better on certain short waves. than night reception, whereas in other short-wave bands the reverse is true.

"The short-wave stations of the world are allocated approximately as follows:

"Police stations—1500 to 2470 kc. —200-121.5 meters.

"Television—2000 to 3000 kc.—150-100 meters.

"Aircraft—1600 to 1700 kc.—187.5-176.5 meters; 3070 to 3256 kc.—night transmission—97.7-92.2 meters; 3452 to 3492 kc.—night transmission—86.9-85.9 meters; 5500 to 5690 kc.—day transmission—54.6-52.7 meters; 6155 to 6410 kc. — day transmission — 48.75-46.8 meters.

"Amateur—3500 to 4000 kc.—86-75 meters.

"American and foreign broadcasting —3660 to 15,000 kc.—82-20 meters (a little telephony and experimental transmission).

"Mixed telephony and broadcasting—9800 to 23000 kc.—30.5-13 meters.

"New proposed television band—35,-000 to 80,000 kc.—8.5-3.75 meters.

"It has been common practice to mark dial calibrations for short-wave receivers in wavelengths. In order to be consistent with dial calibrations now standardized on broadcast receivers, kilocycle or megacycle markings should be employed on all short-wave receivers in the future. All important American and international log books and newspapers are cooperating in bringing about a standardization of kilocycle or megacycle markings.

"Below 25 meters reception is generally more satisfactory during the day than at night, whereas in wavelengths above 50 meters night-time reception is better. It has been found experimentally that wavelengths below 20 meters can be heard only when the path between the transmitting station and the receiver lies entirely in daylight. For wavelengths between 20 to 35 meters, reception is best when either the transmitter or the receiver lies in darkness, but not both.

### Difference in Time

"It is important to keep in mind that the time of day must be taken into consideration in reception of short waves. When it is 8:00 p.m. in New York. it is 10:30 a.m. of the same day in Melbourne, Australia; 1:00 a.m. of the next day in London, England; and 2:00 a.m. of the next day in most of Europe. At these hours the European broadcasting stations are seldom operating. Consequently, in tuning for stations in Europe on the American continents, the best reception is obtained during the afternoon or early evening. Australian stations, on the contrary, will be received in the early morning.

"Schedules, especially from foreign short-wave stations, are difficult to obtain accurately. There are, however, definite schedules kept by some of the

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**RMA engineers outline present status of short-wave radio services**

large foreign stations and these schedules should be ascertained before attempting to receive them. Reception is the primary factor in the sale of a short-wave receiver. Unless a number of stations can be heard and unless this reception is reasonably good, interest in short-wave reception will be lost and sales will suffer accordingly. Good reception cannot be had simply by turning the dial. It is necessary to use one of the various short-wave station logs to know where to find the stations, and it is necessary to know when the stations are on the air.

"The seasons of the year materially affect short-wave reception. Better reception on the shorter waves may generally be expected during the summer months and better reception at 50 meters and above during the winter months. The lower wavelengths are affected least by atmospheric disturbances or static and good results may even be obtained in mid-summer during a severe thunderstorm. On the other hand, these shorter waves are affected more by interferences from trolleys, dial telephones, automobiles, electrical appliances, etc., than the standard broadcast waves.

### Ground and Sky Waves

"In all broadcast waves, reception is known to be received by two paths from the transmitting station, that is, either by the 'ground wave' or by the 'sky wave.' Reception from the ground wave of the transmitter is extremely reliable but can be received only over a comparatively short distance. On the other hand, reception from the path of the sky wave from the transmitter may be at considerable distances. Sky wave reception, however, is critical to seasonal changes, night and day changes, and may develop large 'skip distances' where the station cannot be heard. By skip distance is meant the distance to points in a certain area outside the ground wave range which the sky wave does not touch, making reception in that area impossible. Skip distances are not stable and may change considerably from hour to hour and from day to night. The sky wave and skip-distance theories explain why short-wave reception may be good one day and very poor the next.

"Reception within the ground wave should be good at all times unless shielded by intervening buildings, or unless the local interference at the receiving station is excessive. It is seldom that the ground wave of a short-wave transmitter will be heard. The reliable ground wave distance is approximately 90 miles at 100 meters and only 15 miles at 15 meters. Reception of short waves is mostly obtained from the sky wave of the transmitter. The reliable sky wave, depending whether it is summer or winter, noon or midnight, ranges approximately from 90-2500 miles for 100 meters; 300 miles to an infinite distance for 25 meters; and 700-4000 miles at noontime reception for 15 meters. At midnight for wavelengths lower than 15 meters, the transmitter can only be received within distance of the ground wave. At wavelengths below 7½ meters, there is no sky wave effect whatever and transmission follows more closely optical laws or line of sight transmission.

"The reliable range of the sky wave will vary slowly from season to season, but very rapidly from day to night. The skip-distance is a minimum at noon and increases to a maximum at midnight. The most unusual conditions of reception will be encountered at sunrise and sunset when the most rapid changes occur. The skip-distance is greater when the wavelength is shorter. It is for this reason that wavelengths below 20 meters are useful only during daylight and then over great distances. The maximum reliable range is subject to wide variations due to factors such as static, sun spots and magnetic storms.

### Type of Receiver

"Full entertainment value of short-wave reception is governed by the type of receiver used, the care with which it is installed, and conditions surrounding the receiver. Fading encountered on the short waves, especially at a considerable distance from the transmitter, is much more apt to be destructive of quality than fading on the standard broadcast band. Selective fading and rapid periodic fading are both productive of distortion in the modulation of a radiophone signal. Power has not as much to do with the propagation of short waves as the longer wavelengths. In general, however, greater distances can be covered with less power on the shorter waves.

"Aerial installation for proper short-wave reception is much more important than for reception with a standard broadcast receiver. The aerial should be better insulated, as high as possible, and spaced from metal as much as possible.

"By understanding the foregoing it is plain to see that many factors control reception at the short waves. Influences beyond the control of the systems used make it impossible for reliable receiver manufacturers to guarantee long distance short-wave reception at any time of the day or night. Under favorable conditions it is possible to receive these distant stations with clarity and fidelity, especially in locations remote from metropolitan areas where man-made interference is at a minimum.

"Short-wave receiving development and design are requiring the skill and technical experience of the best radio engineering talent. Efficiency in receiver design is being reached with short-wave converters, short-wave receivers, and all-wave receivers in which the superheterodyne principle is employed.

"The short-wave receiver has a place in the field of engineering. Many phases of its engineering are being considered by committees of the RMA engineering division, such as standardization of dial markings, choice of intermediate frequency and other factors. The short-wave receiver is capable of entertainment value under favorable conditions. Too much stress, however, must not be employed in claims of remarkable reception which cannot be substantiated or duplicated readily."

### Westinghouse Short-Wave Transmitter

The short-wave transmitter of Westinghouse radio station W8XK is now being moved.

The change in location is being made in the interest of centralization and with the completion of the transfer the short waves will go on the air from the ultra-modern plant at Saxonburg, Pa., approximately 30 miles from Pittsburgh.

New transmitting sets are being installed at the Saxonburg plant for the short-wave frequencies of 15,210 kilocycles and 21,540 kilocycles, their respective wavelengths being approximately 19 meters and 13 meters. The most advanced equipment is now being installed, the Westinghouse engineers utilizing the latest scientific knowledge of radio in order to insure that the short wave facilities are the height of modernity. Other short wave frequencies being moved are those of 6,140 kc. or 48 meters and 11,870 kc. or 25 meters.

The achievements of W8XK are known throughout the world. It has carried the National Broadcasting Company programs originating in the KDKA studios to the far corners of the earth. Not only have these short-wave programs of W8XK been received direct on short-wave sets, but millions have tuned in on them after the waves had been picked up and rebroadcast.

Today the short waves of W8XK carry KDKA programs to all parts of the earth. In addition to this, special broadcasts are sent out each Saturday night bearing messages to explorers, missionaries and others in remote places where they are far beyond the ordinary means of communication.

(*Concluded on page* 36)

# The radio of the airways†

By H. C. Leuteritz*

THE following paper deals with the pioneer development of radio communication by the Pan American Airways System and its application on their 20,000 miles of airways between North, Central and South America.

## History

In the summer of 1927 Pan American Airways was formed to start an airline carrying mail and passengers between the southermost point in the United States (Key West) and Cuba. This airway contemplated the longest regularly scheduled flight over water. For this purpose three airplanes were acquired of the Fokker F-7 type seating eight passengers. The company bid and was successful in obtaining the first foreign air mail contract from the United States Post Office Department and operation was started on October 7, 1927. Connected with this group was a man who had considerable experience in airline operation both here and abroad and who appreciated the advantages of radio communication as applied to this service.

This group contacted one of the largest commercial radio companies in this country in order to obtain equipment for use in this service. At that time needs for this equipment being quite limited and due to lack of experience, the best possible delivery date and price was beyond the reach of the company. However, one of the airplanes was carefully inspected in order to determine the limitations which must necessarily be imposed on equipment for this service. Unfortunately the matter was dropped but not forgotten.

The manufacturer in the meantime placed funds at the disposal of their engineers to develop equipment for aircraft use, but due to the company's organization functions, the process was extremely slow of materialization. In the summer of 1928 some equipment was available for test and a survey was made of existing airlines for the purpose of analyzing the demand for equipment and cooperation in testing the models. The only company interested to the extent of supplying facilities aboard their aircraft for test purposes was the Pan American Airways.

The equipment was consequently shipped to Key West, Florida, and was accompanied by two of the engineers. A transmitter was installed in the Tropical Radio station at Miami, Florida, for ground use and was equipped for both telephone and telegraph operation. The aircraft apparatus was likewise so equipped.

Measuring instruments and receivers were set up at Key West and arrangements made with the Naval station to communicate with the aircraft in flight by telegraph. Schedules were also arranged with the Miami station.

Daily flights and measurements were made on the signal strength on c.w., and intelligibility tests on speech using frequencies between 3000 and 2000 kc. The airline distance between Key West and Havana is approximately 110 miles or a flight of one hour and fifteen minutes. These tests were continued whenever possible and during such periods when the equipment functioned.

**The historical development of the radio service on Pan American Airways is here described.**

These tests covered a period of some six weeks. During the latter part of August the power supply for the 100-watt transmitter failed and a spare machine was not available, the best delivery being six weeks. The equipment was therefore removed and replaced by a small set made up of parts purchased locally, using a 171-A tube as an oscillator and batteries for power supply. The results of the tests will be summarized in the following text.

## Early Equipment

The initial equipment produced by the factory consisted of a 10-watt, 100-watt and a 300-watt set arranged for both telegraph and telephone operation. Of the three sets, it was realized at the start that the latter would only be usable aboard airships, due to the combined weight of all units making up the complete set. All three sets operated on any frequency between 3000 and 2000 kc.

The 10-watt and 100-watt sets seemed to give the optimum value of weight per watt output most desirable for aircraft use on any and all aircraft in service at that time. Therefore it was decided to concentrate on further development of this equipment.

The 10-watt equipment was installed on one airplane and the 100-watt set on another. This setup permitted simultaneous tests for both sets on alternate days to determine comparative speech quality and signal on each respective antenna power. Of the two sets, the 10-watt set gave greater fidelity of speech. This set was lost on an airplane which came down in the Gulf of Mexico and sank so that tests were never completed. Of the two sets, this one gave the least trouble.

The 100-watt set gave considerable trouble in flight due to various circuit elements failing and it was practically decided that if this set was to become a commercial product, it would necessitate a complete re-design.

During the latter part of August 1928, two sets were constructed consisting of a panel on which were mounted the component parts, making up the transmitter using the 171-A tube. These transmitters were arranged for telegraph only and were operated in the following manner. The key was locked and the transmitter therefore radiated constantly. This steady signal was received at Key West and signified that everything was OK aboard the airplane. The entire equipment being operated by the flight mechanic. The receiver consisted of a model AR-785 using Western Electric "N" tubes and had one tuned r-f. stage, detector with regeneration and two audio stages. Unfortunately, only one receiver was available which required changing from one airplane to the other each night.

The system was so arranged that the flight mechanic would stop the transmitter and listen for the Key West Naval station NAR. Messages for the aircraft were telephoned to the station and a code was arranged whereby, by means of a series of dots or dashes information could be communicated to the mechanic. These two sets were used until November at which time some new equipment was delivered.

## General

The rapid and continuous progress made in the reliability and range of modern aircraft has necessitated the development of an efficient system of aircraft radio communication.

As a result of several years experience, it has been proven that the success and efficiency of any organized air transport service depends on a rapid and efficient means of communication, not only between terminal and intermediate airports or fields, but also between isolated stations established solely

†*In* Radio Engineering, *February, 1932, appeared a paper by Mr. Leuteritz describing in detail the type of radio apparatus now employed on the airplanes of Pan American Airways.*

**Chief Communication Engineer, Pan American Airways, Inc.*

for weather service or aids to navigation and between airplanes in flight and with ground stations situated at these airports or fields.

In January of 1929 the Pan American Airways decided to set up their own communication department and active work was started on the development of suitable equipment. With the cooperation of the engineering department of the RCA, tests were conducted on various frequencies between 10,000 and 1,500 kc. for purposes of obtaining still further data on propagation over land and water. The 100-watt set was completely rebuilt and improved and installed on a "Ford" operating between Havana and Santiago de Cuba, a distance of 540 miles. Tests on telephone and telegraph were again conducted and verified the results of tests of July and August, 1928 in that for consistent operation telegraph was both faster and more efficient. Intelligibility tests proved conclusively that between aircraft and ground and vice versa, messages under average conditions had to be repeated at least three times before they were clearly understood. These results check very closely with similar tests and observations in Europe[1], and those conducted by Bell Telephone Laboratories.[2]

The tests conducted in July and August 1928 led us to believe that more consistent results and increased efficiency would be obtained by use of frequencies between 5000 and 6000 kc. for daylight operation. This was based on factors of equipment weight and distance. The tests of February 1929 verified this and consequently it was decided to concentrate operations in this band.

Our experience up to this time demonstrated the requirements of operations and the factors affecting design. To meet the requirements of international regulations the aircraft equipment must necessarily be capable of working on 500 kc. while over water and 333 kc. while over land, as well as any other frequencies selected for regular operation.

The specifications laid down for the equipment stated that it shall be as reliable as the aircraft engine performance which was two hundred and fifty hours. This meant that the equipment had to operate without failure for this length of time with only routine inspection.

In order to obtain the degree of efficiency and speed of communication desired to safeguard the aircraft and passengers, it was decided to use a regular licensed operator as a member of each airplane crew. His sole duties were similar to those of an operator aboard a steamship, with the exception that regular contacts were to be maintained with at least three ground stations approximately 200 miles apart. This therefore required consistent operation under all conditions of flight anywhere on the routes of a range of not less than 600 miles. The wisdom of this decision has been demonstrated many times as performance records show.

The system utilizes fifty-nine ground stations located at strategic points on the routes. There are a total of 102 airliners completely equipped with this apparatus, among them being two of the world's largest four-engined flying boats regularly operated on scheduled airways.

## Meteorological Information

The vital importance of an adequate weather service for aeronautics is no longer a subject for debate. It is universally recognized and admitted that the success in maintenance of schedules will depend on the weather.

To handle this particular problem adequately will obviously require a thoroughly reliable meteorological service, including meteorological officers and their equipment, both at airports and bases and at any important topographical points throughout the country over which the aircraft operates where rapid weather changes are likely to occur, in order that weather conditions at any given point may be rapidly circulated to all concerned at frequent intervals.

This is particularly essential on organized air routes in parts of the world where climatic conditions are liable to change from hour to hour.

In many cases the decision as to whether it is possible to continue with the flight or whether to return to the nearest clear airport will depend solely on the information given to a pilot of a plane as to the weather conditions ahead. When it is appreciated that the safety of both passengers and equipment may rely on the rapid and accurate distribution of weather information it becomes evident that radio communication for the meteorological service must be of the highest efficiency.

The manner of handling this type of service is as follows:

In addition to the hourly route weather report special reports of changes in meteorological conditions are issued as follows:

1. *Squalls and thunderstorms.*—The occurrence of a squall or thunderstorm at a station or within visible distance of a weather station is reported to the meteorological office, with the least possible delay.

2. *Changes in visibility.* Special reports of changes in visibilty are issued when the horizontal visibility: a. is decreasing and becomes less than 1100 yards; b. decreases still further and becomes less than 220 yards; c. after having been less than 220 yards has exceeded 550 yards for at least 10 minutes.

3. *Changes in height and amount of clouds.*

I. Cloud height: a. falls below 600 feet; b. becomes still lower and falls below 150 feet; c. after having been below 150 feet has lifted and remained above 300 feet at least 10 minutes.

II. Cloud amount: a. increases so that the sky is more than three-quarters covered (stratus spreading over the sky); b. having been more than three-quarters covered decreases so that the sky has remained less than three-quarters covered for at least 10 minutes (stratus breaking up).

4. *Changes in precipitation.* a. When rain, snow, hail or sleet commences; b. when rain, snow, hail or sleet has been falling, but has cleared for at least 10 minutes.

5. *Changes in wind forces.* a. increases and reaches force 7; b. further increases and reaches or exceeds force 9; c. having reached or exceeds force 8, has decreased and remained at force 6 or below for at least 10 minutes.

The exact weather data to be issued will depend to a large extent on the routes being flown and the organization set up to handle this type of service.

In our own organization each of the airport stations is equipped with instruments to measure the velocity of the wind and direction, temperature both wet and dry, barometer and amount of precipitation. The airport manager and radio operator are both trained weather observers. At certain key stations, instruments and equipment are also supplied to take upper air observations so that pilots may take advantage of any helpful layers of air which are best for flight. As an illustration of this, we find layers in the upper atmosphere where wind velocities are of such a direction and magnitude as to actually assist the airplane in its direction of flight, while lower layers show retarding winds.

Three times daily all airports in a given section forward their observations by radio to the division headquarters where a meteorologist analyzes and compiles his weather maps and issues forecasts and warnings.

Any airplane en route to a given airport is supplied with current weather data so that the pilot is kept informed of any weather changes which are taking place at the airport. In cases of bad or stormy weather, these reports are handled as frequently as five minutes apart so as to permit the pilot to return to his base or take a flight path

(*Concluded on page* 36)

[1] *D. V. L. Report*, 1930.
[2] *Jones-Ryan paper A. I. E. E., Dec.* 4, 1929.

# Desirable tube characteristics

By GORDON D. ROBINSON

▲

**A new point of view, with special reference to screen-grid amplifier tubes**

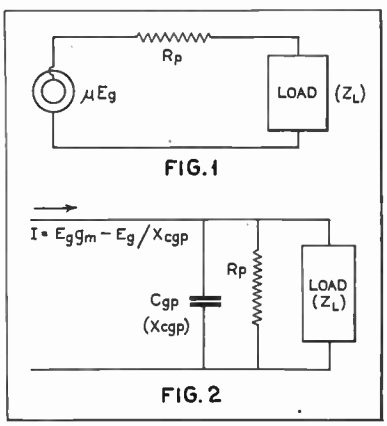
▼

THE long established equivalent circuit which shows an e.m.f. $\mu E_g$ in series with the internal plate resistance $R_p$ and the load impedance $Z_L$ as in Fig. 1 seems to indicate in a rather obvious manner that if one of the tube constants can be changed without influencing the others, it is desirable to have as large a value of amplification factor and as small a value of internal plate resistance as possible. However, either in designing new tubes or in considering the random variation among nominally similar tubes, there is a strong tendency for the amplification factor to vary inversely as the internal resistance thus apparently making their ratio (the mutual conductance or transconductance) more significant than either of the other two constants alone. The intention of this article is to call attention to certain little appreciated relationships which bear especially upon the desirable values for internal plate resistance with a given value of mutual conductance. These relationships are most readily visualized by considering the equivalent *parallel* circuit for the amplifier tube, as shown in Fig. 2.

In Fig. 2 the results to be obtained are predicted by passing the current, which the tube would put out with zero load impedance, through a parallel circuit consisting of the load (both useful and useless) in *parallel* with the internal plate resistance and the plate to grid capacity of the tube. The resulting load current and voltage should then be the values actually obtained. The currents and voltages on the other branches, through $R_p$ and $X_{cgp}$, do not correspond to the actual operating conditions). Since the grid to plate capacity was neglected in Fig. 1, it and the current $E_g/X_{cgp}$ should be omitted from Fig. 2 if it is desired to make this correspond exactly to Fig. 1.

Fig. 2 with this simplification indicates directly that, for a given value of the mutual conductance, *increasing the* value of the internal plate resistance will *increase* the amplification. The same conclusion might be obtained starting from Fig. 1, but it certainly is not obvious therefrom. Since the grid to plate capacity, $C_{gp}$, in screen grid tubes is very small, Fig. 2 simplified by omitting $C_{gp}$ and the current $E_g/X_{cgp}$ should closely approximate the performance of such tubes. Since, in screen-grid tubes, it is possible to have widely different values of internal plate resistance in various tubes which have approximately the same mutual conductance, it is of practical importance to consider the most desirable value of plate resistance for a given value of mutual conductance.

The parallel circuit shows that for given values of mutual conductance and load impedance the amplification produced by the tube and circuit increases rapidly with increase of internal resistance, so long as the latter is comparable to the load impedance. When internal resistance becomes much greater than load impedance, further increase in this produces little effect. It may be noticed that if the internal plate resistance becomes negative a *decrease* in this negative resistance will further increase the amplification.




Figs. 1 and 2. Factors of tube operation.

Fig. 2 also points directly to the importance of large values for mutual conductance. If the internal plate resistance is not changed, the results obtained with a given load impedance will vary directly with the mutual conductance. Doubling the mutual conductance will double the amplification. Neglect of the first condition has led to some confusion in attempting to predict the advantage to be obtained from increasing the value of mutual conductance. Increases in mutual conductance at the expense of decreases in internal plate resistance may be of no advantage.

It may be interesting to compare these theoretical conclusions with the conclusions recently published by Rinaldo de Cola in the December number of RADIO ENGINEERING (p. 15). Mr. de Cola draws qualitatively similar conclusions from arbitrarily considering a series parallel circuit with the d-c. plate resistance in parallel with the load. Since his derivation is partially empirical, the results cannot be expected to be identically the same.

In conclusion it might be well to remark that the action of the by-pass circuit, from screen grid to cathode, has been assumed to be perfect, so that the voltage from screen to cathode remains perfectly constant. Any variation in this voltage due to the operation of the amplifier must introduce results which have been neglected. Furthermore, any deficiency in this by-passing action causes the operation of the circuit to be influenced by the constants of the screen grid. These appear to be widely different for different tubes.

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# Air conditioning for theatre in radio city

INSTALLATION of the six conditioning systems now under way in the two theatres under construction in Rockefeller Center by the Carrier Engineering Corp., has made it necessary for the company to open a special shop in Long Island City, N. Y., where work of shaping and fabricating the sheet metal is being done before installation.

Three centrifugal refrigerating machines with a capacity of 600 tons of melting ice per 24 hours, and three centrifugal refrigerating machines with a capacity of 325 tons of melting ice per day, form the basis of the weather-making system being installed in the 6,000-seat International Music Hall and the 3,500-seat motion picture theatre respectively. Work of installing the air conditioning equipment is being kept up with the general construction which is rapidly progressing, and which when completed is reported will be the last word in modern theatre construction.

Every cubic foot of air going into the theatres, through the system now being installed, will first be filtered and washed. The air conditioning engineers state that it will attain better than 96 per cent freedom from dust, dirt and other molecular organisms.

# Broadcast channels for Canada

IN a communication from the Canadian government to Washington authorities, was outlined the needs of Canada for channels. The letter to the American Government read:

"I have the honor to inform you that the Canadian House of Commons recently appointed a committee to inquire into the whole position of radio broadcasting in Canada. This committee has under consideration a technical scheme for broadcasting in Canada which it is considered will provide satisfactory coverage in the chief population areas throughout the Dominion and at the same time make provision for the community service that may be desired. This scheme is divided into two distinct parts:

"(a) A chain of high-power stations, operating on clear channels, and located at suitable intervals across Canada;

"(b) A number of low-power stations of very limited range, operating on shared channels and located as required for community service.

"If this scheme receives the approval of Parliament, it is proposed to use 50-kw. stations, one in each of the provinces of British Columbia, Manitoba, Ontario, Quebec, and eventually one in the maritime provinces. In Saskatchewan and Alberta it is proposed to use 5-kw. stations at present, two being used in each province, synchronized on a common channel. In Ontario there will be, in addition, two 10-kw. stations, one in western Ontario and one in northern Ontario. Four smaller stations of 1-kw. capacity each are provided for the Port Arthur-Fort William area, and for Ottawa, Montreal and Quebec. In the maritimes, three 500-watt stations are provided for the present, one in each province. The scheme also includes a 500-watt station on the shared channels for the city of Toronto for local service.

"In adopting this plan, Canada would reserve the right to increase the power of the stations in Alberta, Saskatchewan, northern and western Ontario to 50 kw. each, should such increase become necessary.

"In order to insure satisfactory local broadcast service throughout Canada, it is proposed that stations, limited to a maximum power of 100 watts, be erected where necessary, and that they should be operated on shared channels. It is considered that one hundred or more such stations may eventually be required in Canada, and that twenty channels should be available for this type of service. In establishing such stations, it is proposed to maintain the same geographical separation between Canadian and United States stations as is maintained between United States stations of the same power.

"Due notification would, of course, be given of the effective dates of any changes in the present operation to conform with the above plan.

"In the event of the adoption of the above arrangement, it is understood that if, as the result of the Madrid Conference, any additional channels are made available for broadcasting, a further allocation will be made, as between the United States and Canada, on an equitable basis.

"I shall be obliged if you will inform me at your early convenience whether the United States authorities can make the necessary readjustments so that these channels will be available for effective use in Canada."

The American State Department promptly took the matter up with the Radio Commission which, after an executive session, signified that it had no objection to the Canadian plan.

Here is the answer of Acting Secretary of State W. R. Castle to the Canadian proposal:

"I am grateful for your courtesy in informing me by your note of May 5, 1932, of the technical plan which is being considered by the committee of the Canadian House of Commons as a means of providing Canada with satisfactory radio broadcasting coverage. You inquire whether the authorities of the United States can make the readjustment necessary to render certain channels available for effective use in Canada.

"In reply, I am glad to inform you that as notice is given from time to time of the dates of changes to be made in the present operations of Canadian broadcasting stations to conform to the plan set out, this Government will be glad to make the necessary readjustments.

"It is understood that if, as the result of the Madrid Conference, any additional channels are made available for broadcasting, a further allocation will be made, as between the United States and Canada, on an equitable basis."

At the present time Canada has six channels exclusively and shares eleven with the United States. Under the plan proposed by the Canadian committee, here is what Canada would have:

Seven channels exclusive (540, 690, 730, 840, 910, 960, and 1,030, all of which, except 540, Canada has at present).

Six channels for stations up to 1,000 watts, which would be used by both the United States and Canada (600, 630, 780, 880, 930, and 1050).

One channel for a station of 50,000 watts, which would be used by both the United States and Canada (1100).

Twenty channels for stations of not over 100 watts each, to be selected so that no interference would be caused to stations in the United States.

Under the plan recommended by the committee, this would be the allocation of stations in Canada:

540 *kilocycles*. Two stations of 5,000 watts; one in Saskatchewan and the other in Alberta, the two stations to synchronize (the power of these stations may be increased to 50,000 watts).

600 *kilocycles*. One station of 1,000 watts at Montreal.

630 *kilocycles*. One station of 500 watts at Prince Edward Island.

690 *kilocycles*. One station of 50,000 watts at Toronto.

730 *kilocycles*. One station of 50,000 watts at Montreal.

780 *kilocycles*. One station of 1,000 watts at Port Arthur.

840 *kilocycles*. One station of 10,000 watts in western Ontario (power may be increased to 50,000).

880 *kilocycles*. One station of 1,000 watts at Ottawa.

910 *kilocycles*. One station of 50,000 watts in Manitoba.

930 *kilocycles*. One station of 1,000 watts in Quebec.

960 *kilocycles*. One station of 10,000 watts in northern Ontario (power may be increased to 50,000).

1,030 *kilocycles*. Two stations of 5,000 watts; one in Saskatchewan and the other in Alberta, the two stations synchronizing (the power of these stations may be increased to 50,000).

1,050 *kilocycles*. One station of 500 watts in Nova Scotia.

1,100 *kilocycles*. One station of 50,000 watts in British Columbia.

In addition to the foregoing, Canada would use twenty channels for stations of 100 watts, sharing them with the United States.

Here is the present allocation of stations in Canada:

540 *kilocycles*. One station of 5,000 watts.

580 *kilocycles*. Three stations of 500 and one of 250 watts.

(*Concluded on page* 36)

# Government owned radio broadcasting is out

IN the Federal Radio Commission's report, contained in 300 typewritten large pages, submitted to the U. S. Senate on June 8, it is stated that an American government-owned radio broadcasting system would be a costly venture, varying between $100,000,000 and $175,000,000, not including the cost of talent.

The complaint of too much advertising matter in the commercial programs could be cured within the industry, it said.

The commission report disclosed that for 1931 the National Broadcasting Company's operations showed a deficit of $2,241,759, while the Columbia Broadcasting System recorded a profit of $794,724.

The National Broadcasting Company reported gross advertising revenue of $25,895,959 and expenditures of $28,-137,716. The advertising receipts of the Columbia Broadcasting System amounted to $11,621,424, and its expenditures were $10,826,699.

The investment of the N. B. C. was placed at $6,193,670, while that of the C. B. S. was $4,527,459. Principal items in operating costs of the N. B. C. last year included: Programs, $7,868,692; regular employees, $3,710,122; line charges, $2,799,916; research and development, $2,017,542, and other expenses, $12,027,578. Similar expenditures of the Columbia system were placed at $1,329,076 for programs; regular employees, $836,766; line charges, $1,939,443, and other expenses $5,875,-934.

### Can Advertising Be Cured or Reduced?

In response to the Senate resolution's question as to whether it would be possible to have a reduction in the context of advertising announcements on the commercial broadcasts, the commission reported that plans to reduce, limit and control the use of radio facilities for commercial advertising to a specific amount of time must have inception in new and additional legislation. Chairman Saltzman and Commissioner Lafount noted their dissent from the majority on this point.

The use of only a mention of the sponsor of the program would mean a drastic falling off of advertisers from broadcasting, the commission reported. This would mean that there would be a decrease in the quantity and quality of the programs.

"The employment of national surveys of program and station popularity, better showmanship and tact by advertisers and a strict supervision of all programs by licensees of stations should develop a technique that would be more satisfactory to the listening public and beneficial to the industry."

If Congress deemed that the situation justified additional legislation, the commission recommended that the legislation should empower that body with regulatory authority.

"The daily newspaper furnishes a parallel," the report continued. "A newspaper can be sold to the subscriber at a cost greatly under the cost of production because it is used as a medium for advertising and what it contains of a news, educational, literary and entertaining value depends almost entirely upon the revenue received from the sale of space for advertising purposes."

### Would Be "Good-Will" Only

The sponsorship of programs by name alone would amount, in most cases, the commission pointed out, "only to good-will advertising." If these advertisers discontinued their programs, the report said, their action would be reflected "in a decrease both in the quantity and quality of programs available to the public."

"The situation should have its own cure within itself," the commission report emphasized. "There should be a keener appreciation by both the broadcaster and the advertiser that radio facilities not only offer perhaps the greatest opportunity for reaching the greatest number of people, but that their use imposes upon them a very great responsibility for the manner in which programs are presented."

In its analysis of the character of programs of the two major broadcasting chains and larger stations of the country, the commission reported that the sustaining or non-commercial programs constituted approximately two-thirds of the radio's offerings, while the advertising programs made up the remaining one-third of the time on the air. The report cited that government officials, including President Hoover, had consumed many hours in broadcasts during 1931.

### Conditions in Other Countries Not Comparable

Replying to the Senate resolution's question regarding a governmentally-owned and operated radio broadcasting system in the United States, the commission contended that the conditions in Europe, where government broadcasting exists, and the United States are "entirely different" from the viewpoint of the area and the varying populations and interests in this country.

"The policy for the establishment of a government broadcasting system in the United States might take into account," the commission report stated, "the particular interests of the people of the various states with the selection of programs in the control of each state, or all stations could be nationally owned and operated with the selection of all programs in the control of a national organization."

Each policy would require a different system of technical operation, the commission asserted and it is not possible to formulate a definite plan of technical operation without a determination of policy.

"It is estimated that such a system," the commission pointed out, "would require 1,000 stations for each program. To supply three programs would require an initial cost for installation of approximately $120,000,000 with an annual technical maintenance (exclusive of cost of talent) of approximately $100,000,000."

The policy of providing two or more national programs at night throughout the country with one or more stations operated independently by each state to give programs of interest to the states, the commission estimated, would require an initial investment of $50,000,000 with approximately the same amount for maintenance, exclusive of talent.

### Percentage of "Sales Talks" Determined

In its examination of the use of radio time for commercial advertising statements, the commission received reports from 582 stations broadcasting a total of 43,054 hours and the "sales talks" on the air consumed 2,819 hours, representing 6.55 per cent of the total hours used both for sustaining and commercial programs, and 18.11 per cent for the hours devoted only to commercial programs.

"Any plan to reduce, limit and control the use of radio facilities for commercial advertising," the report con-

(*Concluded on page 32*)

## GOVERNMENT OWNED RADIO BROADCASTING IS OUT

(*Concluded from page* 31)

tinued, "must have its inception in new and additional legislation which either fixes and prescribes such limitations or authorizes the commission to do so. While the commission may under the existing law refuse to renew a license to broadcast, or revoke such license because the character of program material does not comply with the statutory standard of public interest, convenience and necessity, there is at present no other limitation upon the use of radio facilities for commercial advertising.

Such regulation, whether specifically undertaken by Congress or delegated by it to the commission, could extend both to the quality and quantity to commercial advertising. While the quality of advertising might and probably would be difficult of adequate regulation, the quantity of such advertising could be limited to certain hours in the day or night and to a certain number of such hours; also, provision could be made limiting the advertising matter to a certain per cent of the time devoted to total programs or commercial programs."

The commission discussed advertising rates in detail, stating that the "circulation" of radio broadcasting is very difficult even to approximate, being a complex of many factors physical and human.

### Low-Power Stations

In the lower-powered stations the commission found there was a longer amount of time devoted to advertising matter in the programs, stations between 500 and 1,000 watts devoting 19.41 per cent to advertising statements; those of 100 to 500 watts, 19.01 per cent; the stations of 1,000 to 5,000 watts, 16.3 per cent; those of 500 watts, 14.6 per cent, and those of more than 5,000 watts, 13.8 per cent.

Of the foreign countries only three—Austria, England and Russia—prohibit commercial advertising announcements on their radio system. In the other nations most of the government broadcasting stations do not accept commercial programs, and these are ransmitted by privately owned stations.

### Restricting Announcements

Discussing the practicability of permitting only the mere announcement of the sponsorship of the commercial programs, the commission stated that this procedure did not appear to be feasible or satisfactory at the present time, as "the American system of broadcasting is predicated upon the use of radio facilities as a medium for local and national advertising."

Commercial programs, the commission found, furnish the principal source of revenue to stations, and the quality and character of sustaining programs depend upon the revenue received from the sale of time for commercial advertising purposes.

The commission further pointed out that "radio broadcasting in the United Staes has grown to be a very large industry" with 607 stations located so as to insure consistent radio reception over about 46 per cent of the entire country at night and for 89.6 per cent of the American population. The investment in the industry amounted on December 31, 1931, to $48.000,000 and during 1931 gross receipts totaled $77,758,048, while gross expenditures aggregated $77,995,405, including $20,159,656 for talent and programs. All but forty stations of the 607 in the United States are privately owned and operated and the remainder are under the control or operation of states and municipalities.

### 33.8 Per Cent Sponsored Programs

Analyzing chain broadcasting the commission stated that the National Broadcasting Company reported for 1931 out of its total broadcasting time of 20,160 hours 66.2 per cent comprised sustaining programs, 33.8 per cent commercial or sponsored programs. The Columbia Broadcasting system during the same year "made available to its network 6,550 hours of programs, of which 21.9 per cent was commercial and 78.06 per cent sustaining. On the NBC chains the commission reported that a total of 4,336 hours and 53 minutes of sustaining educational programs were broadcast, while on the Columbia system this category of programs aggregated 1,225 hours.

The report stated that the commission had granted licenses to ninety-five educational institutions to operate radio transmitters, of which fifty-one were public institutions and forty-four private institutions. In no case, the report said, had the exclusive use of a clear channel been given to an educational institution's station, but in only a few cases had permission for an educational station's use been refused. It was the opinion of the commission that these broadcasts "can be safely left to the voluntary gift of the use of facilities by commercial stations."

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## NEW MARINE WIRELESS STATION COMPLETED AT VANCOUVER (CANADA)

EXPERIMENTAL tests of the new government short-wave wireless station on Lulu Island are being conducted. It is reported to be the most modern short-wave station on the Pacific Coast and its equipment was made entirely in Canada. The station is unique in that it will have no operators, its only staff being the men in charge of the mechanism. Dials, similar to those of automatic telephones, give the wavelength required, and are operated from Point Grey or Vancouver Merchants' Exchange stations of the government service. It is a sending station, while Point Grey and Merchants' Exchange remain the receiving stations, though, if necessary, the Lulu Island station will receive. It is not necessary, however, the officials stated, because of the efficiency of the present stations. The Lulu Island plant is located on Williams Road, between No. 1 Road and Railroad Avenue, the lines from Merchants' Exchange being 13.5 miles long and those from Point Grey 14 miles. (*Trade Commissioner E. G. Babbitt, Vancouver, Canada, 2/25/32.*)

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## UNITS USED TO EXPRESS WAVELENGTHS

### 1. Spectroscopy

"Angstrom" (abbreviate A)
1 angstrom= 0.0000001 millimeter,
or
=1.000 milliangstroms.

### 2. Röntgen or X Rays, and Gamma Rays[1]

"Milliangstrom" (abbreviate mA)
1 milliangstrom=0.0000000001 millimeter[2].
=0.001 angstrom.
"Microangstrom" (abbreviate μA)
1 microangstrom=0.000001 angstrom.
=0.0000000000001 millimeter.

### 3. Radiometry

"Micron" (symbol μ); or any of above-named units.
1 micron= 0.000001 meter.
= 0.001 millimeter.
= 1,000 millimicrons.
=10,000 angstroms.

### 4. Colorimetry

"Millimicron" (symbol mμ)
1 millimicron= 0.000000001 meter.
= 0.000001 millimeter.
=10 angstroms.

### 5. Radio Communication

"Meter" (abbreviate m)
1 meter=fundamental unit of length.
= 1,000 millimeters.
=10,000,000,000 angstroms.
"Millimeter" (abbreviate mm) for waves under 1 meter
1 millimeter= 0.001 meter.
=10,000,000 angstroms.

[1] *Wavelengths of ultra-penetrating rays notably shorter than gamma ray waves may be expressed in terms of the "microangstrom" (symbol μA).*
[2] *One X-unit=1 milliangstrom.*

—*From a bulletin of the Bureau of Standards.*

## FURTHER EXPERIMENT BY MARCONI IN WIRELESS TELEPHONY

IN November, 1931, Senator Guglielmo Marconi gave a demonstration of the result of experiments made with ultra-short radio waves for the transmission of radiotelephone conversations over short distances. At that time the experiment was conducted between the Villa Repellini at Santa Margherita Ligure and the house of Baron Massola at Levanto (about 31 miles apart). The success of his efforts was manifested by the clear transmission of his voice to the assistant at Levanto. At that time, however, the instrument used did not permit of conversation in both directions. During recent months Senator Marconi has so improved the apparatus that, by means of very short wave lengths (about 52 centimeters) a clear transmission of conversations with the duplex system is now possible over comparatively short distances. This seems to have been satisfactorily demonstrated when a second experiment was made on April 6, 1932, between the Villa Repellini at Santa Margherita and a tower in the park of the Villa Gualino at Sestri Levante (about 15 miles). A two-way conversation took place and the voices were clearly heard and resounded distinctly from the microphones. The system now perfected is not an entirely new discovery but rather an application of radiophone possibilities to short distance communications and seems to insure immunity from "listening in" as well as from interruption by electric disturbance. Press reports indicate that the new system's field of utility may be extended by employment in connection with wire telephones, for the apparatus is said to be constructed in such a way that it can be linked up with the exchanges functioning by means of wires, that is, it will be possible to pass a conversation over wires to a wireless communication. For example, the voice of a person at Turin who wishes to talk with some one on an island would be carried by means of the telephone wires to the coast and from there transmitted by the new system to the receiver on the island. (*Consul General W. Roderick Dorsey, Genoa, Italy,* 4/12/32.)

▲

## FREQUENCY DEVIATION TOLERANCE AT BROADCAST STATIONS

THE Federal Radio Commission reports that approximately two-thirds of the broadcast stations now have installed frequency control equipment that has the capability of maintaining the operating frequency within 50 cycles of the assigned frequency as required by Rule 144 which becomes effective June 22, 1932. In conjunction with this equipment, an approved frequency monitor must be employed.

Three frequency monitors have been approved to date and others are now being tested at the Bureau of Standards. All stations must have in operation by June 22, 1932, an approved monitor to be operated in conjunction with the transmitter so as to determine that the station is operating within the rigid frequency deviation tolerance specified. The monitors are considered necessary to maintain the close frequency requirements and are required by Rule 145.

Under the present rules. broadcast stations are required to maintain their operating frequency within only 500 cycles of the assigned frequency. Such operation subjects duplicated channel stations to severe mutual interference in the form of whistles and heterodynes. The new rule eliminates these whistles and heterodynes, thereby increasing the service area of all stations that are now limited in service.

It is the expectation of the Commission that when the new rule goes into effect all stations will be equipped with frequency control and frequency monitors so as to observe the new frequency deviation tolerance.

The chief beneficiaries of the new rule will be those listeners located fairly close to a station but now unable to receive it satisfactorily due to interference from other stations on the channel. By the new rule this interference will be materially reduced and thereby the stations will serve larger areas. All stations that are now suffering from heterodyne interference will have their service areas increased. It is estimated that this increase in service area will be from 25 to 100 per cent for all duplicated channel stations now suffering heterodyne interference.

▲

## RADIO BROADCAST ADVERTISING CONTINUES RISE

OWING in important measure to substantially larger expenditures by the tobacco, drugs and toilet goods and foods divisions, radio advertising continued a sharp uptrend in the first quarter of 1932. The respective gains over the similar 1931 period were 51 per cent, 50 per cent and 36 per cent, in the three monthly periods. Again, the newspaper was the largest loser to the radio. Expenditures of advertisers for radio broadcasting now total about one-third of those for magazine lineage and one-fourth those for newspaper lineage.

A principal cause of large radio advertising continues to be a desire on the part of the advertiser to try a new medium in the hope of stemming declining sales. Verifying the experimental nature of much radio advertising are figures of "Media Records" which show that 96 advertisers, or slightly more than a third of those who used chain broadcasts in 1930, withdrew from this medium in 1931. Likewise, 153 new advertisers tried broadcasting in 1931.

Such experimentation is likely to continue on a large scale until business recovery takes place; at such a time, a sharper growth in expenditures should be recorded in the older media. Meanwhile, volume of radio advertising is close to a peak, owing to the natural limitations created by a fixed number of available hours and the complete coverage of principal cities with stations. Thus, the principal basis for growth in expenditures over the near term will be the price of talent used in broadcasts. As the tendency at present is to spend more for talent, indications are that early future appropriations for radio advertising will continue to advance.—*May 20, Report of Standard Statistics Co., New York.*

▲

## WIRELESS COMMUNICATION IMPORTANT DURING MALAYAN FLOODS

THE wireless communication system of the Posts and Telegraph Department, Federated Malay States, proved to be of considerable value during the recent floods which occurred on the East Coast of British Malaya. Rail traffic and communication between Kuala Lumpur and the East Coast were seriously interrupted during the floods and the only means of communication was by wireless from small customs launches along the East Coast and the Petalling Hill station at Kuala Lumpur. Small transmitting and receiving stations are now maintained throughout the State of Pahang and it has been decided to abandon the telegraph line which connects Kuala Lumpur with the East Coast in favor of wireless telegraphy, due to the excessive cost of maintenance. During the flood period which existed throughout December, an average number of 150 messages daily were handled between Kuala Lumpur and Kuantan. The wireless telegraphy system between Kuala Lumpur and Kuantan is used as a link in the telegraphic system of Malaya. Telegrams forwarded from certain parts of Pahang to Singapore are transmitted by the coastal land-line to Kuantan, from whence they are wirelessed to Kuala Lumpur and then passed on to the central telegraph office in Kuala Lumpur for transmission by ordinary telegraph to Singapore. (*Assistant Trade Commissioner Donald W. Smith, Singapore, Straits Settlements,* 1/25/32.)


THE Group Subscription Plan for RADIO ENGINEERING enables a group of engineers or department heads to subscribe at one-half the usual yearly rate.

The regular individual rate is $2.00 a year. In groups of 4 or more, the subscription rate is $1.00 a year. (In Canada and foreign countries $2.00.)

The engineering departments of hundreds of manufacturers in the radio and allied industries have used this Group Plan for years, in renewing their subscriptions to RADIO ENGINEERING.

Each subscriber should print his name and address clearly and state his occupation—whether an executive, engineer, department head, plant superintendent, or foreman, etc.

**Remember this Group Plan when *Your* Subscription Expires**

***(Radio Engineering)***

**Bryan Davis Publishing Co, Inc.**
**19 East 47th Street**
**New York, N. Y.**

Los Angeles Chicago St. Louis

## A FORMULA FOR OPEN AREA OF WIRE CLOTH

By W. F. Schaphorst, M. E.

THE formula that is generally used for finding the open area of wire cloth is somewhat cumbersome because it goes at the problem backwards. It gives the closed area, and then we are told to subtract that area from one (1). The answer will be correct, of course, but the method is clumsy. The following formula gives the open area directly:

$$\text{Open area} = (1 - ND)(1 - nd)$$

where N = number of wires in the warp per inch;
n = number of wires in the shoot per inch;
D = diameter of wires in the warp;
d = diameter of wires in the shoot.

To accomplish the some purpose the "old" formula, revised somewhat, would be as follows:

$$1 - ND(1 - nd) - nd$$

where the meaning of the symbols is the same as given above. Both formulas give the same result, to be sure. but the first is simpler.

▲

## RADIO'S FUTURE

AFTER a good many years of comparative unimportance. the American home is enjoying an astonishing popularity. It is once more the center of things.

A number of influences were responsible for the temporary eclipse of the home. A man used to work from ten to twelve hours a day. Then he had to spend two or three hours in a barroom or lodge to get feeling human again. His wife worked even longer hours because no one had thought of making housework easy. Of course the children didn't find that sort of home attractive and sought happiness elsewhere. Then the movies came, and for a while the exodus was complete. The low-priced car followed and people started in to see what the world looked like.

But just check off what has happened. People now do most of their entertaining at home. That is probably what started this back-to-the-home movement. The clean automatic heater has made possible the popular "Rumpus Room" in the basement, with a return of ping pong and pool. Shorter hours have given people more time to enjoy their homes. Then old-fashioned housework disappeared with the advent of electric appliances, washing machines, automatic refrigerators, oil or gas heaters, vacuum cleaners and such. and women took up interior decoration and bridge. Radio finished the job. An evening that doesn't offer your choice of one hundred thousand dollars' worth of entertainment is the exception.

You can have dance music of the finest, comedians of the $5.50 revues, grand opera right from the stage, the world's greatest instrumentalists, play-by-play football from California to Maine. spot news. ringside seats, a chat with the President, after-dinner oratory, philharmonic symphonies, historical drama, home hints. and, incidentally, quite a lot of information about merchandise. When you come to think about it calmly, it is a bit unreasonable for a man who has enjoyed, for nothing, superb entertainment that would have cost him fifty dollars outside his home to protest bitterly against the few minutes devoted to commercial announcements.

Of course television is still a laboratory adventure, but so was radio a few months before about every second home had it.

Radio has only scratched its possibilities. So far, we have barely grasped the rudiments of how to build a radio program that will please twenty million listeners. Big minds are planning big things. We might even go so far as to give radio some educational value. Keep your eye on the radio—it's still an infant.

If you are making something that adds to the comfort and pleasure of home living, don't lose hope.—*From The Wedge, Batten, Barton, Durstine and Osborne, New York.*

▲

## ONWARD MARCH OF SHORT-WAVE RADIO

(*Concluded from page* 26)

An innovation in use of short-wave broadcasting is being performed each Sunday evening in the Westinghouse Personalities program. These broadcasts are for both the English and the Spanish speaking people.

The music of the programs is sent out on both the short and the standard waves of KDKA and W8XK. Ralph Leavenworth, Westinghouse general advertising manager, then speaks in English and his talk is sent out only by KDKA. At the same time a Spanish talk is delivered on W8XK. At the conclusion of the two addresses the short and standard wave units are connected to the same microphone for the musical part of the program.

▲

## THE RADIO OF THE AIRWAYS

(*Concluded from page* 28)

which would avoid a storm area and still permit completion of scheduled flights.

In addition to this service, a plane cannot depart from an airport until the pilot is in possession of weather reports from at least the next two other airports on the route over which he will fly. En route he supplies weather data as to the condition being encountered for further dissemination to planes which will cross these areas at later intervals.

This type of service must be very efficient and requires the minimum delay as otherwise flight schedules may be badly hampered and can cause serious accidents unless carefully watched. This particularly holds true where rapid climatic changes occur as in the tropics.

▲

## BROADCAST CHANNELS FOR CANADA

(*Concluded from page* 30)

600 *kilocycles.* One station of 500 watts.

630 *kilocycles.* Three stations of 500 and one of 50 watts.

645 *kilocycles.* Two stations of 100 watts.

665 *kilocycles.* Two stations of 500 and one of 100 watts.

685 *kilocycles.* One station of 2,000 watts.

690 *kilocycles.* One station of 10,000 and two of 500 watts.

730 *kilocycles.* One station of 5,000, three of 100, and one of 50 watts.

745 *kilocycles.* One station of 500 watts.

780 *kilocycles.* One station of 5,000 watts.

815 *kilocycles.* One station of 500 watts.

840 *kilocycles.* One station of 10,000 and one of 1,000 watts.

880 *kilocycles.* One station of 100 and three of 50 watts.

890 *kilocycles.* One station of 500, one of 100, and one of 50 watts.

910 *kilocycles.* One station of 5,000 and one of 500 watts.

915 *kilocycles.* One station of 100 watts.

930 *kilocycles.* One station of 500, one of 100. and one of 50 watts.

960 *kilocycles.* Three stations of 500 and one of 100 watts.

985 *kilocycles.* One station of 10.000 watts.

1.010 *kilocycles.* One station of 50 watts.

1,030 *kilocycles.* Two stations of 500 watts.

1,120 *kilocycles.* Two stations of 500 and two of 100 watts.

1,155 *kilocycles.* One station of 25 watts.

1,200 *kilocycles.* One station of 100, two of 25, two of 15, one of 10, and one of 5 watts.

1,210 *kilocycles.* One station of 500, one of 250, one of 100, and one of 50 watts.

# Specify Racon Speakers

The leaders do! Engineers in the best companies specify them for their finest installations. The largest theatres in the world, amusement parks, airports, public buildings and the U. S. Naval Hospitals . . . all are satisfied Racon users.

We point with pride to RACON's accomplishments during the past 10 years as the pioneer manufacturer of air column horns and electro-dynamic speaker units.

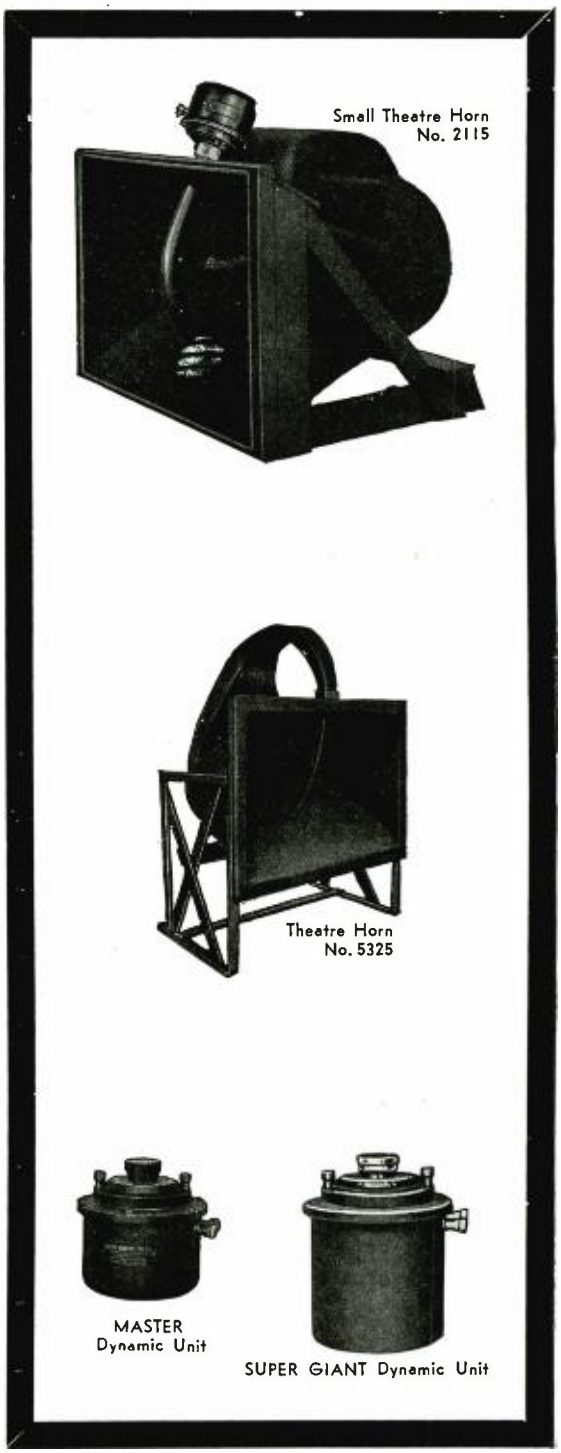
RACON Horns are superior in reproducing high frequencies, especially at high volume. Distortion is impossible, tone quality approaching that of the human voice is assured.

## *The "Outdoor Season" Is Here!*

RACON "all-weather" Horns are unconditionally guaranteed against climatic conditions, rain, heat, snow, aridity—nothing can affect RACON Horns.

RACON Horns are constructed of an exclusive patented *non-vibratory material without resonance, so common in other type horns.

● *RACON'S Catalog P.E. 6 will be sent on request if you use your business letterhead or card.* ●




RACON ELECTRIC CO. INC.

52 East 19th Street, New York City

London, England Toronto, Canada

*Racon Horns and Units are Covered by U. S. Patents Nos. 1,507,711; 1,501,032; 1,577,270; 73,217; 73,218; 1,722,448; 1,711,514; 1,781,489; 1,842,608; 1,834,327; 1,835,739; 1,845,210


### GRID-LEAKS

Grid-leaks are high resistances (up to 10,000,000 ohms) employed in modern radio receiver circuits.

The earlier types of grid-leaks consisted of a sheet of paper coated or impregnated with a small amount of conducting substance. Contact was established by metal eyelets which also served to hold the protecting paper label in place.

Aquadag was much used in this style of leak just as it is popular in the currently used hermetically sealed type.

A rod of glass or unglazed porcelain is treated with Aquadag which has been properly diluted with distilled water to give a film having the desired resistance characteristics. After being subjected to a fairly high temperature, sufficient to drive out all occluded moisture, the rod is usually sealed in glass tubing which serves to protect the resistance element from abrasion and changes in humidity. Some manufacturers prefer to varnish or lacquer the element, thus making unnecessary the use of an outer jacket or shield.

In designing grid-leaks employing Aquadag, it should be borne in mind that graphite possesses a negative temperature coefficient.

Aquadag brand Colloidal-graphited water, manufactured by The Acheson Oildag Company, Port Huron, Mich., has a graphite content of approximately 22 per cent. It is sold in glass containers.

▲

### RESISTORS

Resistors—carbon, wire-wound, vitreous enamel, strip and flexible; bakelite, mica. paper and cartridge, are manufactured in all sizes and resistances, by the Electro-Motive Eng. Corpn., 797 East 140th St., New York.

▲

### TRANSMITTING CONDENSERS

Thoroughly dependable condensers for radio transmitting purposes are made by the Allen D. Cardwell Mfg. Co., 91 Prospect St., Brooklyn, N. Y. These range from small condensers in many capacities to giant condensers for high-power installations.

▲

### NEW BROADCASTING DEPARTMENT CREATED BY WESTINGHOUSE

The creation of a radio broadcasting department is announced by J. S. Tritle, vice-president and general manager of the Westinghouse Electric & Manufacturing Company.

The new department will consolidate all radio broadcasting and associated activities of the Westinghouse Company. Before the grouping of the various radio functions into the new department such activities were split among several other departments and bureaus of the Westinghouse Company.

Walter Evans has been appointed manager of the new department. He joined the Westinghouse Company in 1921 when he became an operator of Station KYW. Before leaving the station in 1928 he had become its manager. By subsequent steps he advanced until he was placed in charge of Westinghouse radio activities.

Chief among the radio stations operated by the Westinghouse Electric & Manufacturing Company is KDKA of Pittsburgh. Other Westinghouse stations are WBZ, Boston; WBZA, Springfield, Mass.; KYW and KFKX at Chicago.

▲

### RACON MOVES

The Racon Electric Co., manufacturers of air column speakers and electrodynamic units, have moved their offices and factory to new and more spacious quarters at 52 E. 19th Street, corner of Fourth Avenue, New York City.

▲

### INTERNATIONAL RADIO LICENSED

Announcement was made May 18 by the Radio Corporation of America that a radio broadcast receiving set license has been issued to the International Radio Corporation, of Ann Arbor, Michigan.

▲

### POCKET PORTABLE INSTRUMENTS

With these compact voltmeters, capacity meters, ohmmeters, etc., unusually long mirror type scales, are available. Direct current and thermocouple types are provided in single and multirange instruments to meet all needs. They are manufactured by Jewell Electrical Instrument Co., 9 Haynes Ave., Newark, New Jersey.

▲

### 1932 STANDARDS YEARBOOK, PUBLISHED BY BUREAU OF STANDARDS

The increasing importance placed upon standardization by governments and world-wide developments along this line, as well as various other scientific achievements, are discussed in "The 1932 Standards Yearbook," published by the Commerce Department's Bureau of Standards. Considerable detail is given on standardization work being done in the United States.

Subjects covered in this book range from accident prevention in zoning systems and include references to important work having a direct bearing on reducing the cost to the public and increasing the profit of manufacturers of a wide range of articles.

"The sections on national and international standardizing agencies contain information not found elsewhere in one volume," said Director George K. Burgess of the Bureau of Standards. "This information would be almost impossible to obtain elsewhere because of the difficulty of searching through all the original sources."

To the non-technical reader, the first section of the Yearbook, a symposium on standardization in communication, is one of the most interesting features of the publication.

Standardization is the basis of all communication, though the extent of this development is but little appreciated by the layman, said Director Burgess.

Other sections of the book contain brief reports of the work of standardizing bodies within the Federal Government and of States, counties and municipal agencies, as well as technical societies and trade associations.

Copies of Standards Yearbook may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., for $1 each.

▲

### PHILCO USES NEW TUBES

James M. Skinner, president of Philco Radio, in announcing the employment of new type tubes for Philco receivers, says:

"Philco has introduced a number of new, improved tubes for very definite technical reasons, in the interest of economy and standardization. We will standardize on 6.3 volt heater types. Every engineer and every dealer knows of the superiority of heater type tubes, and every one is familiar with the trend, during the years, from filament to heater types. Furthermore, the use of 6.3 volt heaters as standard permits their application to automobile and d-c. receivers, as well as to a-c. receivers, so that all new developments in Philco tubes in the future will immediately be available for all these classes of service.

"In efficiency, in economy of current and space, in uniformity, in freedom from trouble and in all-around performance, the new Philco 6.3 volt universal-service tubes are superior to any tubes that we know of, past or present.

"And even more important, the fact that they have been designed specifically for the new Philco receiver circuits in the Philco laboratories, with tube engineers and receiver engineers working together toward a common goal, enables us to state confidently that the new Philco receivers using these tubes will give performance unequalled in other receivers."

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### NEW RESISTANCE CODE CHART

The Ohio Carbon Company, Cleveland, Ohio, is distributing a new R. M. A. resistance code chart which is being found valuable by engineers in radio manufacturing plants. The chart is a recognized time saver.

▲

### COMPLETE LINE OF RELAYS

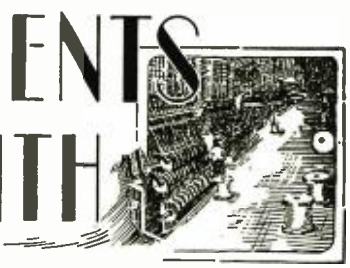
A complete line of small current relays for all purposes, designated in various types, such as: quick acting, slow acting, slow releasing, mechanical locking, vacuum contact, mercury contact, polarized, etc., both a-c. and d-c., is being marketed by the American Automatic Electric Sales Co. Information may be obtained from L. F. Shea, general sales agent of the company at 21 East 40th St., New York.

▲

### NEW QUARTERS FOR DAVEN

The Daven Company, manufacturers of resistors, attenuators and decade resistance boxes, are now installed in their new offices on the fourth floor at 158 Summit St., Newark, N. J.

# NEW DEVELOPMENTS OF THE MONTH



### HAMMARLUND PRODUCES NEW "BAND SPREAD" CONDENSER

To assist in constructing short-wave receivers having the much desired band spread tuning characteristics, the engineering department of the Hammarlund Manufacturing Company, Inc., 424 West 33rd Street, New York City, has designed a new type "band spread" midget condenser.

Two sections are provided in the condenser, one having a capacity of 100 uuf. and the other a capacity of 35 uuf. Each section may be individually tuned by its own shaft. Tuning to the center of the desired band is accomplished by the high capacity section, the low capacity section then being used for "spreading the band"

and so greatly simplifying tuning within the limits of the band.

The condenser is specially designed for efficiency on high and ultra high frequencies. Bearings are heavy and accurately fitted, plates are of brass, and no nuts or screws are used, all joints being securely soldered. Adapted for either base mounting or single hole panel mounting.

▲

### WESTON PHOTRONIC ILLUMINATION CONTROL RELAY

The Weston photronic illumination control relay model 609 has been designed to turn lights on and off in accordance with the daylight intensity so that a certain predetermined level of illumination may be maintained. Time switches have never been the real answer to this problem for even with astronomical clocks no allowance is made for dark days or stormy weather. The "electric eye" on the other hand constantly watches the light intensity and when it falls below the value for which it is set, it passes the information on to relays and the lights are turned on automatically.

Never before has such simple and trouble-free equipment been offered for this purpose. The photronic illumination control relay consists of but two parts: (1) The light collector and (2) the relay cabinet. The light collector is the device containing the photronic cells which is mounted on the roof facing the north sky or in the room, the illumination of which is to be controlled. The relay cabinet contains the necessary relays for controlling circuits up to 3,000 watts at 110 volts and may be located at the most convenient place for simplifying the installation.

The equipment may be adjusted to operate at the following levels of light illumination intensity:

| Low | | High |
|---|---|---|
| 5 | ..... | 10 foot-candles |
| 10 | ..... | 20 foot-candles |
| 15 | ..... | 30 foot-candles |

or at any values in between or higher if so desired. This is a simple contact adjustment, but should be done at the factory to insure proper settings.

Application:

The Model 609 has the following fields of applications:

1. The control of street lights.
2. The control of sign lights.
3. The control of airways beacons and air field lighting.
4. The control of light houses.
5. The control of school and class room lighting.
6. Controlling factory lighting.

▲

### SEMI-DRY CONDENSERS

The Condenser Corpn. of America, 259 Cornelison Ave., Jersey City, N. J., announces a line of semi-dry Acracon condensers with peak operating voltage of 500 and a surge voltage of 800, with low initial leakage. These condensers have a stable power factor which does not increase with age. They are made with metal or fibre containers.

▲

### WIRE-WOUND RESISTORS

The Aerovox Corporation, 70 Washington St., Brooklyn, N. Y., announce a new line of wire-wound resistors.

The new resistors, types 930, 931, 932 and 933, illustrated herewith, are wound on a porcelain tube with a special high grade resistance wire of low temperature coefficient. The entire unit is completely coated with a newly developed refractory compound which resists wear and will not chip or crack. The 5 watt resistors, type


931, of the same dimensions as standard 1 watt carbon resistors, type 1094.

All units are provided with pig tail terminal leads 2 inches long for mounting and wiring and can be made in all standard resistance values up to the maximum.

### TWO-BUTTON MIKE

The new model 33N Shure 2 button microphone embodies the acme of refinement in design. Greater improvements in performance, utility, and appearance are incorporated in this new model than in any other two-button microphone. No expense has been spared in making an instrument that will bring the joy of satisfaction to everyone who owns or uses it. The following are a few of its unique and outstanding features:

1. Reproduction of music and musical tones and frequencies that makes older microphones obsolete just as the newest radio set excels in its tone quality and richness of bass notes the radio reproduction of five years ago. This is accomplished by means of the specially selected alloy used in the diaphragm material and its special clamping and stretching method which does not employ the use of a large number of screws.

2. True, natural reproduction of the

speaking voice. The carbon hiss, characteristic of many microphones, is at such a low level in the model 33N that it cannot be heard by the average human ear. The frequency response is as uniform as can be accomplished with this type of microphone from 30 to 8,000 cycles. Exacting laboratory testing is employed from start to finish. Model 33N has no harmonics of its own and never distorts, the frame being of a very heavy special alloy.

3. High sensitivity—low current. A remarkable feature of Model 33N is that sufficient sensitivity is obtained for all practical purposes with a current consumption of only 6 to 8 ma. per button. Sensitivity can be increased by additional current, but this model never consumes more than 15 ma. per button.

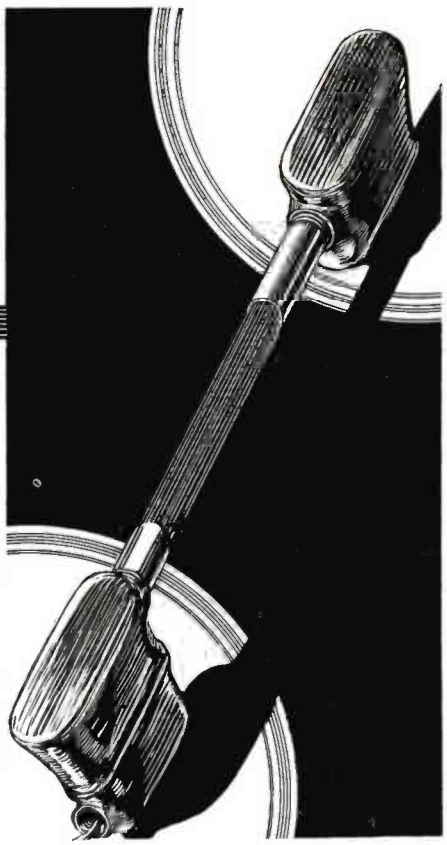
Manufactured by Shure Brothers Company, 337 West Madison St., Chicago, Ill.

▲

### TRANSFORMERS

Transformers for radio receivers, designed to make the most of the output from the new tubes, are being marketed by The Thordarson Electric Mfg. Co., 500 West Huron St., Chicago, Ill.

# NOW INDUSTRIAL ENGINEERS and ELECTRONIC EXPERIMENTERS . . . A way to Utilize the Photo Electric Effect (Electric Eye) IN A THOUSAND NEW FIELDS THRU A NEW INSTRUMENT OF EXCEPTIONAL SENSITIVITY . . .



## THE OPTISCOPE

(T. M. REGISTRY APPLIED FOR)

With the development by the Electro Control Company of the OPTISCOPE a technically practical assembly, electricity yields much of its hitherto latent possibilities for the engineer, the experimenter and the industrialist.

Before the OPTISCOPE all photo electric units available were either prohibitive in price, unadaptable to commercial and serious experimental applications or of mere novelty value, and adequate technical and commercial information for users, research workers and dealers, in this new field was not obtainable.

Now in the OPTISCOPE, the Electro Control Company provides a unit, at a low price, of such exceptional sensitivity as to bring within its range literally thousands of practical applications, many of them of immediate and high commercial value.

Here is a compact rugged unit in a solid aluminum case, which with the wiring for three circuits that comes with it, is ready for several hundred applications. And a separate light source unit in heavy aluminum housing is included with the OPTISCOPE, together with free instructions and diagrams for the various hook-ups.

. . . . Write today for full information on the OPTISCOPE, stating what experimental or commercial application of the instrument most interests you.

**THE ELECTRO CONTROL COMPANY ...Manufacturers Electroscopic Equipment . . . Maintains electronic research laboratories...Disseminates electrical data and diagrams on applications of the OPTISCOPE . . . Provides technical and commercial advice and helps for dealers and experimenters.**

**ELECTRO CONTROL COMPANY**
**43 East Ohio Street .. Chicago, Illinois**

# RESINOX

## FOR DEPENDABLE MOLDED PARTS

◆ Resinox Molding Compounds assure you of molded parts of dependable dielectric quality, of great strength and durability, and of lustrous surface beauty. Our technical staff will gladly assist your molder, in his own plant, with any molding problem your parts may present. It will pay you to specify "Made with Resinox."

## RESINOX CORPORATION

A SUBSIDIARY OF COMMERCIAL SOLVENTS CORPORATION AND CORN PRODUCTS REFINING CO.

230 PARK AVENUE NEW YORK CITY

# Volume Indicator Panel

For Broadcast Speech Input Systems, Recording and Public Address Installations. Rectifier type, laboratory calibrated with

## Range —16 DB to +32 DB

Mounted on Standard 19" x 7" x ¼" Black Enameled Aluminum Panel.

Price in U. S. A. net f.o.b. Chicago

(Code LISPS) ..... $80.00

*Send for Bulletin 8C*

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*ENGINEERS*

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French Office: 16 Rue de Chateaudun, Asnieres
Mexican Office: Av. 5 de Mayo 10, Mexico, D. F.
Indian Offices: Ismail Bldg., Hornby Road, Fortn, Bombay
43/1 D Dharamtola Street, Calcutta
Japanese Office: 9 Minami-Sumiya-Machi, Osaka
Chinese Office: 20 Nanking Road, Shanghai

### NEW RADIOTRONS

Due principally to the increase in power of broadcasting transmitters, radio engineers since 1927 have concentrated their attention on the radio-frequency system of the radio set.

Now, with the introduction of the type 46 dual-grid power-output amplifier and its companion, the type 82 mercury-vapor rectifier, set designers can "open up" on the audio system and provide a strong, new appeal to the set buyer.

The large reserve power available through the use of the 46 and 82 is an efficient preventative of "blasting," rattling and distortion—bugaboos of sets whose power tubes were subject to overload. While the maximum available power may seldom be needed, the fact that it is available will make for better all-round performance. An 8-cylinder engine provides more horsepower than a light car ordinarily needs, but the car's average performance is better for the fact that such power is in reserve.

It should be borne in mind that even a barely perceptible increase in volume requires a very large increase in power supplied to the loudspeaker.

Radiotrons 46 and 82, together with companion types 56, 57 and 58 of the new super-phonic series, enabled set manufacturers to "step on the gas" with strikingly new receivers having an instantaneous attraction for the buying public.

▲

### VOLTOX

Voltox, a new resistance wire, is the product of the Gilby Wire Co., 150 Riverside Ave., Newark, N. J. It has capacity for 6 to 8 volts, and is particularly suitable for potentiometer and rheostat winding.

▲

### JUVENILE REPRODUCERS

Juvenile reproducers Model 225, by Wright De Coster, St. Paul, Minn., are made especially for the manufacturers of high quality radios and sound instruments. The Juvenile has that rich mellow quality of tone so desirable for radios and phonographs.

As it has a maximum power handling capacity of 6 watts the Juvenile is suitable for installation in practically all sound reproducing instruments to be used indoors.

Field resistance can be made to specifications and output transformer furnished to match output tube or tubes.

Cone, 10 inches; outside measurement of cone bracket, 12⅛ inches; depth, 8 5/16 inches. Weight, packed one in a carton, 18 lbs.

▲

### CAPACITORS FOR ULTRA-SHORT-WAVE TRANSMITTERS

Short-wave problems which extend even to transmitting condensers particularly when working in the ultra-short-wave region of 5 meters, have led to the development of a sulphur dielectric unit type capacitor by the engineers of the Dubilier Condenser Corporation, 4377 Bronx Blvd., New York City. The unique design, featuring a ceramic body with flat and extending top and bottom members, permits of stacking and bolting together a number of these units for series and parallel combinations in obtaining various multiples of capacity, voltage and current requirements. Each unit measures approximately 2½ inches in diameter and 1 inch high, with the mounting holes 3 inches on center lines. This capacitor is offered in three ratings: 10 uuf., 5,000 peak volts, 7 amperes at 60 mc. or 3.5 at 20 mc.; 15 uuf., 4,000 peak volts, 9 amperes at 60 mc., or 5 at 20 mc.; and 20 uuf., 3,000 peak volts, 10 amperes at 60 mc., or 6 amperes at 20 mc.

Capacitor units of this type are successfully employed for grid or plate blocking use, as well as for tank circuit, or as a booster in parallel with the variable air capacitor in the tank circuit, especially where several frequency bands are to be covered.

▲

### THE OPTISCOPE

To meet the growing demand for a unit utilizing the photoelectric effect whereby light energy is converted into electrical and mechanical energy, the Electro Control Company of 43 East Ohio Street, Chicago, is introducing a complete unit consisting of an exceptionally sensitive photoelectric cell, amplifier and relay. The relay is especially adapted to work in conjunction with equipment drawing not more than one ampere. The unit is housed in a solid aluminum case of rugged construction and will withstand outdoor weathering.

Another similar case, housing a con-

centrated filament light source and transformer, is provided as an exciter. The light source has an adjustable telescope for focusing the light beam as desired.

The unit may be wired in about thirty minutes, using any one of several circuits to render the device universally serviceable on 110 or 220 volts a-c. or d-c. lines.

▲

### B SUPPLY FOR AUTO RECEIVERS

This complete unit consists in a dynamotor, a filter, and a voltage divider mounted in a totally enclosed, non-corrodible metal box. An insulated shielded cable is also supplied to prevent the possibility of noise pickup from the leads, and a control switch is mounted in the box for operating the dynamotor.

The dynamotor is of special design. All parts are proportioned for maximum efficiency, and the construction is exceptionally rugged. The bearings, brushes and commutators are considerably larger than is customary for machines of its size. The machine is liberally rated and is exceptionally reliable, requiring practically no maintenance. The design is carefully worked out, so that there is very little voltage fluctuation or ripple, and with the filter perfect results are obtained with the popular auto receivers.

All parts are given a special process, rendering them non-corrodible, and the unit is carefully assembled to withstand excessive vibration, as experienced on an automobile. The shielded cable is furnished with insulation outside the shielding to prevent interference caused by possible rubbing of the metal shielding against metal parts of the car.

The machine takes less current than the parking lights, requires no attention, and will outlast any automobile, giving long and satisfactory service without attention. It is a product of the Electric Specialty Co., Stamford, Conn.

▲

### HIGH-LEVEL TUBE-TO-LINE TRANSFORMERS

The distortionless operation of output power tubes, which may be excited into the grid current region, requires that a rather high impedance be reflected into the plate circuit. The provision of a high load impedance also tends to reduce distortion when the grid swing is more conservative. Combining this important property with excellent efficiency and frequency response characteristics, is the outstanding feature of the transformers listed in Specification Sheet 4, issued by Silver-Marshall, Inc., 6401 West 65th St., Chicago, Ill. All items are for push-pull circuit arrangements.

▲

### CABINET MANUFACTURE

Quite a number of set manufacturers and cabinet manufacturers are making use of the new Zapon sanding sealer No. 5959, which was created to fill an important requisite in cabinet finish. It is easily sanded and most adaptable of all pyroxylin sealers on the market.

▲

### NEW 2.5 VOLT TUBE

The new series of 2.5 volt tubes, types 46, 56, 57, 58 and 82, is announced by Arcturus Radio Tube Company, Newark, N. J., who is in production on all five types.

The type 46 is a duo-grid power amplifier tube, for use as a Class B amplifier, or as a driver tube in Class A amplifiers. It is possible with a pair of 46's when used as Class B amplifiers to secure an output up to 20 watts of undistorted power.

Type 56 is of small size and can be used as a detector, amplifier or oscillator. It is of the indirectly heated cathode type, designed for relatively low heater power consumption.

Type 57 screen-grid detector amplifier and type 58 variable-mu r-f. pentode tubes are of the "dome" type construction. The shield arrangement in the dome

decidedly reduces the output capacity, making these tubes ideal for sensitive short-wave receivers.

The Arcturus 82 fills the demands for increased power and the use of Class B amplification. The voltage drop across the tube remains almost constant as the load is increased until the total emission of the filament is approached, insuring improved regulation and long life.

All of these tubes, because of their reduced size, contribute to economical set design.

# INDEX OF ADVERTISERS

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The Confidence Portable Tube Tester reaches the 75% of public who cannot or will not remove their tubes from the radio to be taken to a store for tests — use this portable device and get most of the replacement tube business. In interprets everything and your customer believes it—they know what is happening because it is in English. Slip-hinge cover removes for counter use.

Counter type, $59.50 net. Meter faces customer, otherwise the instrument is the same as Portable, except it is housed in an attractive black leatherette covered counter housing. Placards are mounted on side panels reading "Free Tube Testing."

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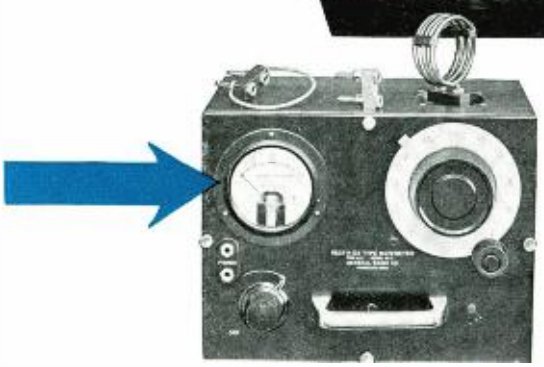

*Rectifier-type Wave Meter*

*Output Meter*

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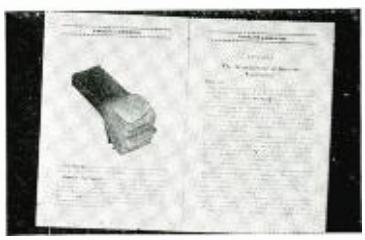

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