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DECEMBER
1938

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COMMUNICATIONS

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RAY D. RETTENMEYER
Editor

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Cover Illustration: Felix the Cat has been turned into a grinning guinea pig as the subject used most often in the NBC experimental studio, RCA Building, New York. Felix sits around the studio night and day on call, then comes before the RCA Iconoscope to show his clarity when transmitted for this picture with 441-line definition. NBC photo.

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WITH THE EDITORS

BROADCAST ENGINEERING CONFERENCE

THE SECOND ANNUAL Broadcast Engineering Conference, sponsored by the Department of Electrical Engineering, The Ohio State University, will be held in Columbus, Ohio, from February 6 through 17.

In view of the distinct success of last year's gathering considerable interest is being evidenced in this meeting, which will bring together industry leaders and practicing engineers from all parts of the United States and Canada. Complete details will appear in the January issue of COMMUNICATIONS. In the meantime, remember the dates, February 6-17, The Ohio State University, Columbus, Ohio.

WAVE-GUIDE TRANSMISSION FOR TELEVISION

CONSIDERABLE work has been done by Southworth and others on the transmission of ultra-high frequencies (around 2,000 megacycles) through hollow conductors . . . or preferably using a conductor filled with an insulating material. Good results have been obtained experimentally although guided waves are not yet being used commercially.

If it is possible to obtain a satisfactory insulating material at a fairly reasonable cost, this form of transmission might well assume considerable importance. This is especially true in case of television where the problem of program distribution is of major importance. It is hardly difficult to visualize the broadcast and television networks of the future using some such means in place of the present program lines.

NAB PROGRAM STANDARDS

THE NAB Committee on Procedures recently made a recommendation on program standards and practices to the Board of Directors. The resolution stated that:

"(1) In view of the growing complex social order of American life, a committee be appointed to re-evaluate the NAB Code adopted in 1935;

"(2) That the committee secure from all stations and networks copies of existing program policies and practices;

"(3) That from a comprehensive study of these, and with full consideration of those program problems for which the industry has not yet reached a final, satisfactory solution, the committee draft a suggested and inclusive revised NAB Standards of Practice for member stations, and with full provision for the method of enforcement included therein;

"(4) That a copy of the Standards of Practice, when finally approved by the Board of Directors, be submitted to all NAB broadcasters for their individual study, prior to the next annual meeting, at which time the entire membership will consider the matter in convention."

This move towards industrial self-regulation would seem to be a step in the right direction.

RMA CONVENTION, RADIO PARTS SHOW

THE FIFTEENTH ANNUAL RMA Convention and National Radio Parts Show will be held together next June at the Stevens Hotel in Chicago. The RMA gathering will be held Tuesday and Wednesday, June 13 and 14, while the National Radio Parts Show will be held from Wednesday, June 14, to Saturday, June 17.

FACSIMILE TO THE FORE

AS WE have pointed out before, much interest is being evidenced in facsimile. At the present time there are approximately sixteen licensed experimental facsimile stations in this country. Ten of these are now on the air, two will soon begin field tests, while others are awaiting delivery of equipment. Also, plans for public demonstrations of radio facsimile at the New York World's Fair are under way. Further, it has been rumored that facsimile kits will soon make their appearance on the market.

In view of this and the general interest in the subject, it seems safe to predict that commercial facsimile is not too far distant.

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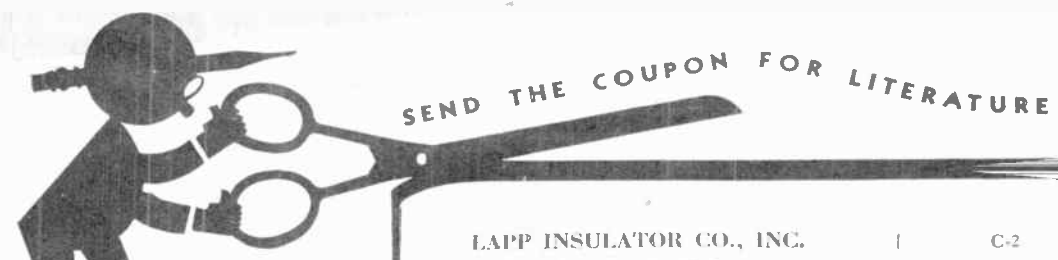

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COMMUNICATIONS

FOR DECEMBER, 1938

ELECTRIC RESONANCE CHAMBERS

By GROTE REBER

INTRODUCTION

TUNED CHAMBERS have been used as terminations for waveguides. Used alone as sources and sinks of electromagnetic energy they have other remarkable characteristics. This paper deals only with that mode of excitation termed H_1 by Southworth[1] and transverse by Barrow[2].

THEORY

Consider a nearly closed cylindrical chamber as shown in Fig. 1-A with a wavefront of energy P advancing from left to right. During one transit of the chamber ΔP energy will be taken from the wavefront by loss in material of which the chamber is constructed and that absorbed by the antenna wire L. In a properly designed chamber the ratio of the latter to the former is very large so that the former may be neglected. This wavefront will be reflected at the left and right ends of the chamber with efficiencies e_1 and e_2 respectively. Fig. 1-B is a line diagram of what happens to the wavefront during successive transits. The vertical arrows indicate the energy taken out by dipole L and may be summed up as eqn (1). Δ, e_1 and e_2 are fractions.

$$E = \Delta P\,[1 + (1 + (1 - \Delta)\,e_2)\,((1 - \Delta)\,e_1 + (1 - \Delta)^3 e_1^2 e_2 + (1 - \Delta)^5 e_1^3 e_2^2 + \ldots + (1 - \Delta)^{2n-1} e_1^n e_2^{n-1})] \quad \ldots\ldots (1)$$

TABLE I

CHAMBER SELECTIVITY AS A FUNCTION OF OPENING A AND DISTANCE D

A (inches)	5/8	1	1½	2	3
B (inches)	Chamber Q				
3/16	313	145	46	.	. . .
¼	216	111	35.5	13.9	. . .
5/16	121	60	29.3	10.1	
⅜	.	49	24.1	8.1	1.3
7/16	.	43	15.4	6.2	1.0
½	.	26.3	10.7	4.5	.7
9/16			8.3	3.6	.6
⅝	.		6.8	2.5	.5
¾	.		.	1.8	.5
⅞			.	1.4	.5
1				.	.4
1 3/16	.		.	.	.4

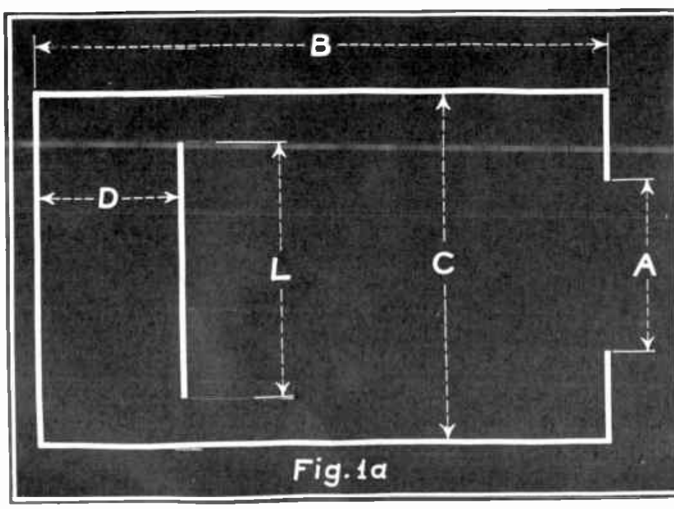
This expression is convergent for $0 < \Delta,\ e_1,\ e_2 \leqslant 1$. When P is taken as unity eqn (1) gives the efficiency of the chamber. Figs 2-A and 2-B give computed efficiencies for various values of Δ, e_1 and e_2. While it is profitable to make Δ as large as possible quite good operation can be obtained with very small values if the reflection efficiencies are maintained high.

EQUIPMENT

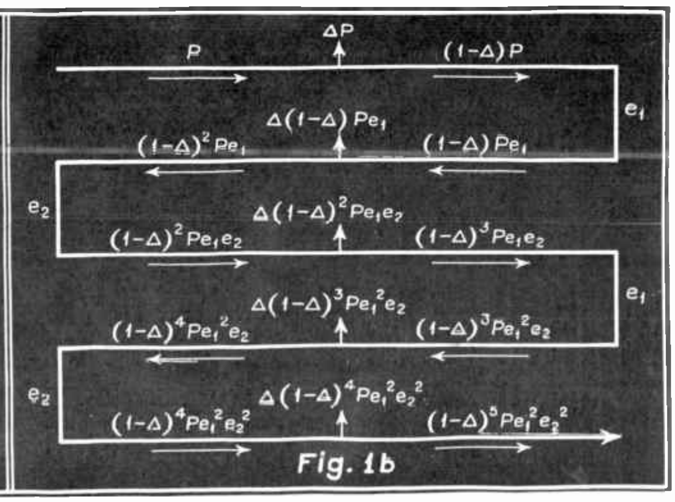
Most of the following data was taken with the equipment shown in Fig. 3. The chamber is 3″ I.D. and fitted with movable piston and an assortment of sliding caps which provide various diameters of opening A and length B. An iris diaphragm was tried but did not work out well due to poor contact between leaves and especially from the base of the leaves to the walls of the cylinder.

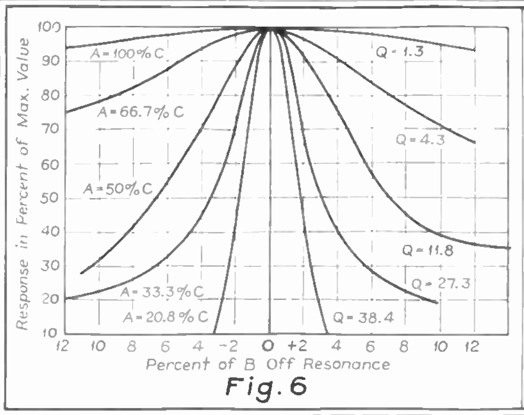
The detector was an adjustable crystal mounted at the center of a dipole 2″ long. An artificial sphalerite (zinc sulfide) was found most successful. Silicon, carborundum and galena were also tried and found inferior in order

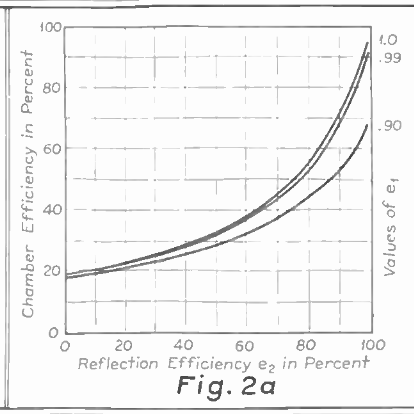
Section through electromagnetic resonance chamber.

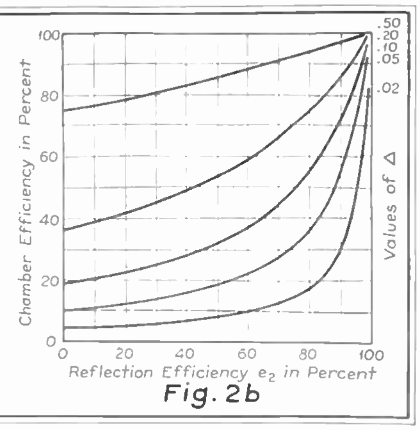


Effective path of wavefront.









Chamber selectivity as function of A and D.

Chamber performance as function of e_2 for $\Delta = 0.1$.

Chamber performance as function of e_2 for $e_1 = 1.00$.

named. This detector very closely approximated a current-squared rectifier and worked into a 450-ohm microammeter. All response readings given are the square root of actual current readings.

The oscillator was a magnetron operating in the electronic transit time fashion. The radiator consisted of merely the transmission line shorting bar 5/16″ long acting as an effective point source. The opening of the chamber was maintained at 16″ (3 to 5 wavelengths) from radiator.

CHAMBER RESONANCE

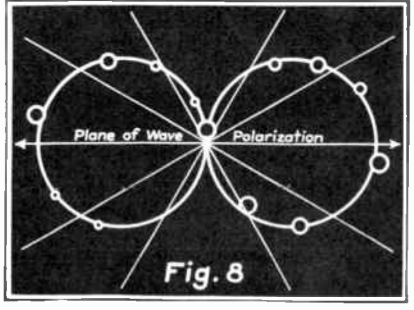
It was found the chamber could be tuned to resonance in a large variety of manners depending upon the circuit parameters as shown in Fig. 4. The curves are divided into families α, β, γ, etc. The type α is unique while β, γ, etc., are repetitions of a second type. The peculiar crossing over of lines in modes β, γ, etc., is hard to explain; however, the bump in ¼″ curve may be due to the fact that the crystal chamber was ⅜″ diameter and consequently large compared to D for small values of the latter. Dotted lines indicate the transverse and longitudinal cutoff frequencies of 2305 and 3002 mc respectively. The size of the opening A had only a small effect upon B. This relation is shown in Fig. 5. These and other readings designated α, β and γ were made at 2450, 2930 and 3730 mc respectively. The radius of the circles is the probable error of point using a variety of D.

From tests at 893 mc using acorn tubes and antennas which could be tuned, the following appears to be the way in which the chamber acts. If the dipole L is maintained with fixed mechanical dimensions, and resonance noted for maximum current, this will occur when net reactance is a minimum. The net reactance is a combination of antenna reactance and the reflected reactance from the chamber. This reflected reactance from the chamber is a function of wave velocity, such that the farther away the operation point is above a system of curves the greater the inductive reactance, and the farther below a system of curves the greater the capacity reactance. At some line between the system of curves, the reactances become infinite and an anti-resonance condition occurs, such that no response whatever is obtained. The change in B with change in D for fixed frequency is merely a compensation to bring the reflected reactance back to the same value. Actually it has been found that any chamber may be resonated to practically any frequency above the cutoff frequency, irrespective of A, B and D, merely by juggling L and the antenna tuning to compensate for whatever reflected reactance may be present. The above mentioned anti-resonance points are sharply defined and no response can be obtained even when the source is placed only a few percent of a wavelength from the opening. The smaller the opening the sharper the tuning and the greater the attenuation. Tests were made at 99% of cutoff frequency and no resonance effects could be found. The only response was due to leakage into the chamber which with small opening was negligible.

CHAMBER SELECTIVITY

As B is varied from the resonant value, the response will fall off along some curve depending upon the selectivity of the chamber. Typical curves taken at 2930 mc, with D = 1″, are shown in Fig. 6. The Q was computed from the shape of the nose of the curve. A more complete tabulation for 2450 mc is given in Table I.

Response of chamber when turned axially.



Apparently the chamber damping is greatly influenced by the size of opening A and only slightly by other parameters. This leads to an interesting analogy. The whole device may be considered a transformer where the space outside the chamber is represented as an untuned primary and the space inside the chamber is a tuned secondary coupled by the opening A. In such a

Fig. 3. Apparatus for experiment with resonance chambers.

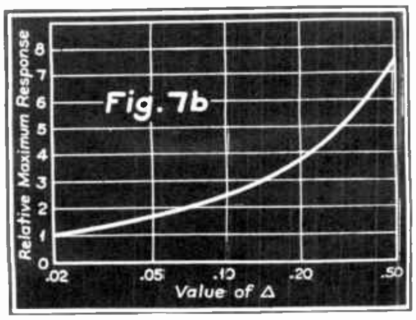
device the resultant selectivity is reduced as the secondary is more tightly coupled to the primary.

The downward trend of Q with increasing D is apparently due to variations of Δ. The results seem to indicate $\Delta \leq 1/Q$. By using a small opening, a short antenna and making the chamber of good conductivity, Q's of several thousand can probably be attained.

CHAMBER RESPONSE

The response may be calculated by multiplying the coupling and the chamber efficiency. Figs. 7-A and 7-B show the results obtained for $e_1 = 1.00$ and a variety of Δ and e_2. The coupling was taken proportional to A and $e_2 = 1 - A^2/C^2$. The measured values are shown for modes α and β. No data was taken for mode γ because of the spurious responses due to longitudinal waves being present.

Points above A = 50% C suggest a value of Δ about 0.10. The readings below A = 50% C are not particularly good and because of critical adjustment are somewhat low. The resonant condition used for this data was the combination of B and D producing the maximum response for any given A. While each value of D required a different B to cause resonance there was some value which was the best value. Apparently the other combinations were not true resonance points but merely minimum reactance conditions.



Maximum response as function of Δ.

Reference to Table I shows in general the measured Q to be equal or less than 1/Δ for A > 50% C.

The transformer analogy is again of interest because here the response increases with increased coupling (increasing A) to some critical value and then decreases similar to the overcoupled condition. The critical value of coupling also increases as the secondary damping (Δ) is raised. Points M are for dipole L at position of opening A with chamber removed. Points N are the same with the reflecting plate a quarter wave behind the antenna. These seem to indicate Δ near 0.10 if the chamber efficiency is 50% at A = 50% C. See curve for Δ = 0.10, Fig. 2-B.

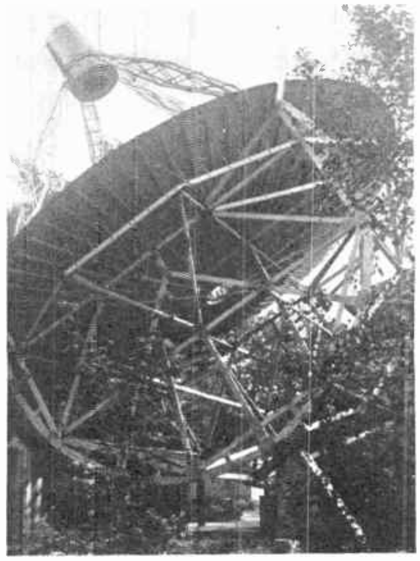


Fig. 12. Directional antenna, using chamber with parabolic reflector.

SPACE PATTERN

The chamber may be turned in three manners; each one producing a different response curve.

When turned on the axis of the cylinder always keeping the plane of the opening perpendicular to the direction of received energy the points of Fig. 8 are obtained. The solid curve is $r = \cos \theta$. This response curve is independent of mode of resonance or dimensions A, B and D.

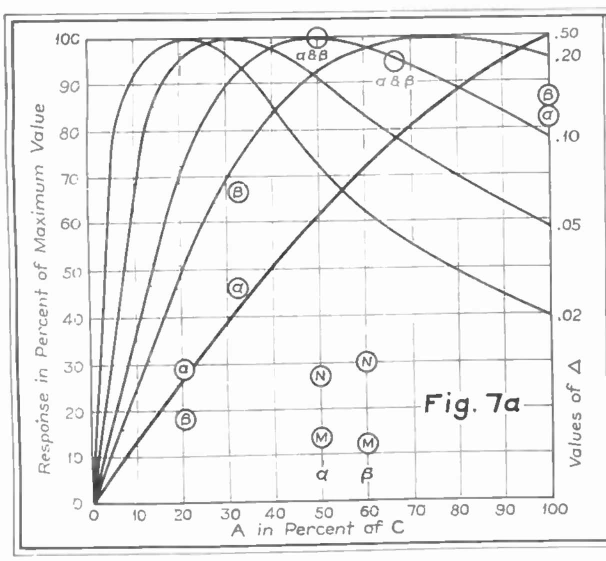
When turned on the axis perpendicular to the dipole through the center of opening A the points of Fig. 9 are obtained. The solid curve is $r = (\cos \theta)^{3/2}$. Again this response curve is independent of any of the above parameters.

When turned on the axis parallel to the dipole through the center of the opening A, the points shown in Fig. 10 are obtained. The solid curve is $r = (\cos \theta)^2$. The response pattern sharpens up slightly for the higher modes of excitation but again the pattern is independent of A.

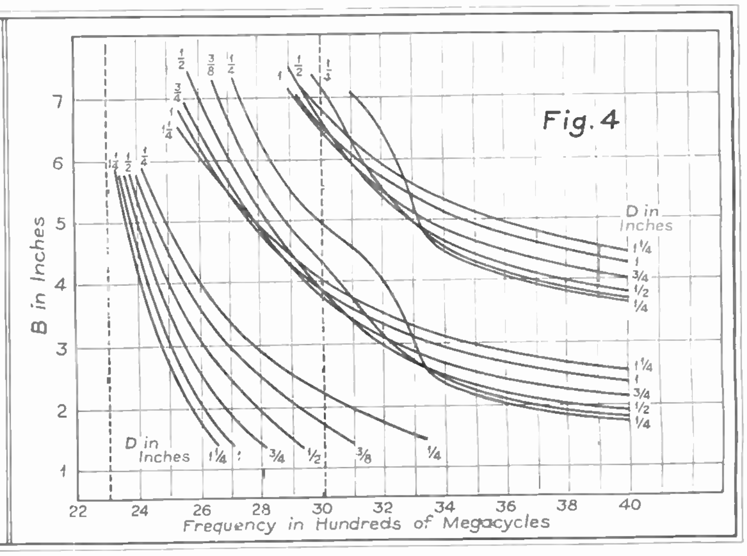
The radius of the circles is the probable error of the point in question. Each of the above sets of data is the mean of 8 to 17 readings taken using various combinations of A, B and D in on and off resonant conditions.

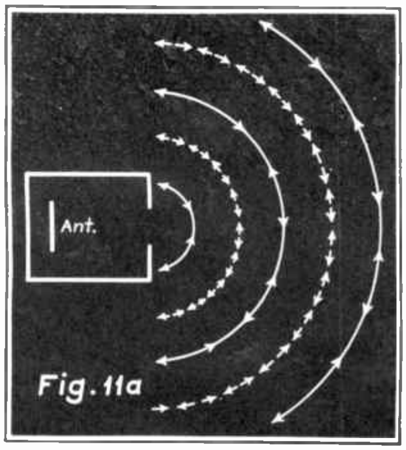
These results on space pattern are somewhat different from Barrows statement that the ratio of the free space wavelength to the aperture will influence the shape of the radiation pattern. While he gives no experimental proof, the horns of his Fig. 22 presumably all have apertures of several wavelengths. In contrast varying the aperture of the chamber 5 to 1 below one wavelength produces no measurable change in pattern. If the data of his Fig. 21 is reduced to intensity at con-

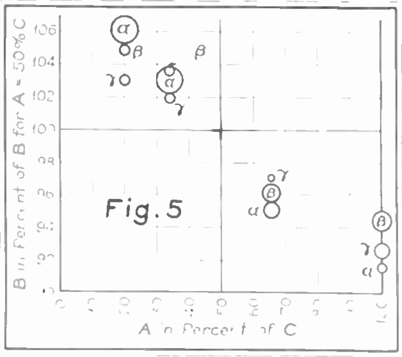
Chamber response as function of coupling.

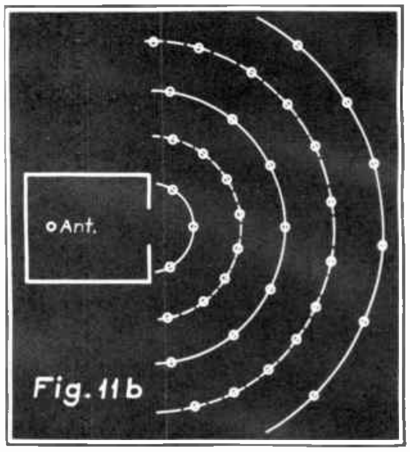


Length of chamber as function of D and frequency for A = 50% C.









Above: Length of chamber as function of A for modes of tuning. Left: Vertical view through plane of dipole. Double arrows indicate direction of probe (electric field). Right: Horizontal view through plane perpendicular to dipole. Circles indicate direction of probe (electric field) always perpendicular to paper.

stant distance instead of distance at constant intensity an $r = (\cos \theta)^2$ curve will be obtained in close agreement with Fig. 10, α, below. There was no measurable effect on pattern with eccentricities of L up to 10% C.

CHAMBER USED AS A RADIATOR

A few tests at 893 mc using acorn tubes as oscillators and a steel drum of fixed dimensions ($C = 11\frac{1}{8}''$, $B = 12\frac{1}{2}''$, $D = 2\ 7/16''$) showed the same type of space patterns as exhibited in Figs. 8, 9 and 10 to exist independent of A for values tried $50\% \ C \geq A \geq 20\% \ C$.

When tubes were adjusted to barely oscillate they could be thrown into or out of oscillation by moving a half-wave probe rod around near opening. These zones were plotted and found as shown in Figs. 11-A and 11-B to be independent of A. The solid lines indicate minimum absorption and dotted lines maximum absorption. The electromagnetic wavefront appears to emanate from a point at the center of and in the plane of the opening. This point can be shifted slightly inside or outside of the opening by mistuning L. It is interesting to note that considerable tighter coupling to the oscillator was required with a small A to produce the same loading. Apparently the coupling of the chamber to space (also radiation resistance of L) was reduced and to radiate the same power a more intense field was required at A. This increased field required greater current in L and tighter coupling to the oscillator.

While the chamber will serve as a radiator of moderate directivity in itself greatly improved results can be obtained in conjunction with a parabolic reflector. The aperture of the chamber is effectively a point source so that when placed at focal point of the parabola a radio beam of nearly parallel rays may be obtained. The angle of divergence will be $\phi = \tan^{-1} A/R$ where R is the focal length of the mirror. When used as a receiver the chamber becomes a sink of wavepower at the focus. Such an arrangement for the investigation of extraterrestrial static is shown in Fig. 12.

TABLE II
SHIELDING EFFECT OF VARIOUS MATERIALS COVERING THE OPENING OF THE CHAMBER

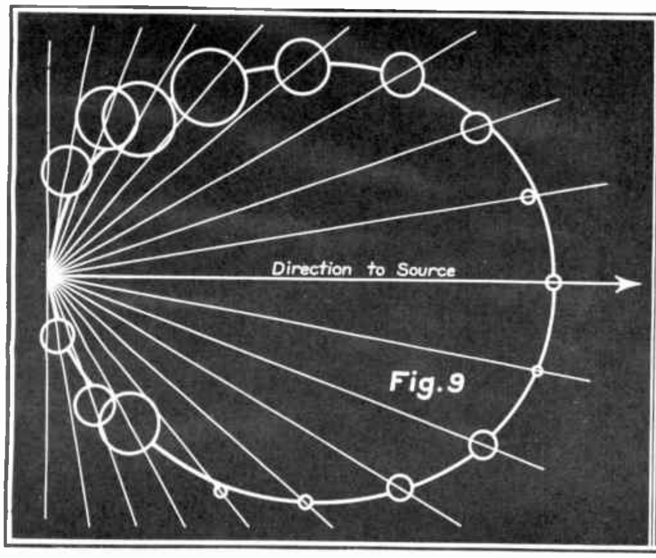
Material	Percent reduction in response
No cover	0
Dry cloth (.24mm thick)	0
Water soaked cloth	48
Dry crepe paper (.15mm thick)	0
Water soaked crepe paper	28
Dry tissue paper (.04mm thick)	0
Water soaked tissue paper	6
Dry netting (2.5mm mesh)	0
Water soaked netting (no water in mesh)	4
Water soaked netting (meshes full of water)	35
Bakelite (4.5mm thick)	16
Asbestos side shingle (4.5mm thick)	23
Aluminum foil (.06mm thick)	90
Dry oak board (19mm thick)	55
Dry oak board (5mm hole)	53
Window glass (2mm thick)	8
Window glass (film of water on one side	14
Human hand	75

ADDENDA

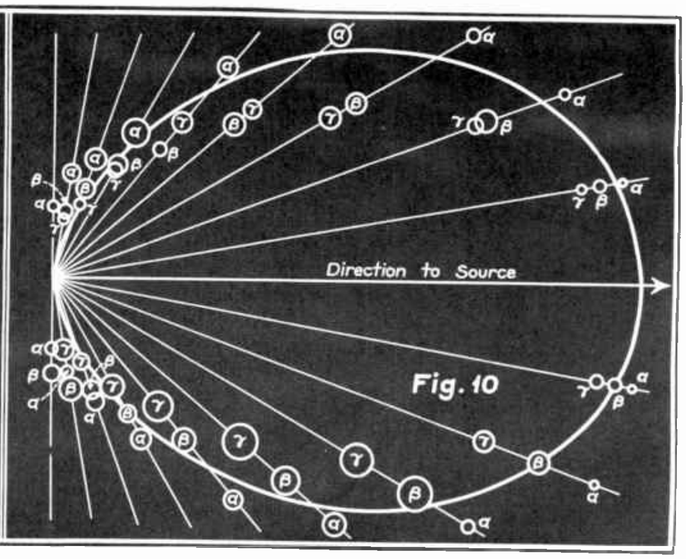
Most uses of the chamber will require some type of covering for the opening. Table II gives the performance of a

(*Continued on page 25*)

Response of chamber when turned in plane of dipole.



Response of chamber when turned in plane perpendicular to dipole.



The Influence of Grid Focusing Effect on
PLATE DISSIPATION LIMIT
of a Vacuum Tube

By I. E. MOUROMTSEFF

Special Products Engineering Department
Westinghouse Lamp Division
WESTINGHOUSE ELECTRIC & MANUFACTURING CO.

IT IS A known fact that the anodes of vacuum tubes operated with highly negative grids are frequently heated non-uniformly, showing some regular patterns of hot spots. It is also known that such regular "hot spotting" is a result of the focusing effect of the negative grid, compelling the electrons to fly through the grid meshes in thin sheath formations or electron beams concentrated along center lines between grid wires. A theoretical analysis of this phenomenon is the purpose of the present paper. More precisely, we are going to investigate the effect of divers factors contributing to the non-uniform heat distribution in the anodes in the presence of a pronounced grid focusing effect. By way of example, we shall apply our investigation to a more or less conventional water-cooled tube having a cylindrical copper anode and perfectly symmetrical grid and filament structures.

The focusing effect in such a tube can be expected in two directions: along the tube axis, due to the turns of the grid winding of thin wire: and in a circular direction, caused by the heavy longitudinal grid stays. The important role of the grid stays can be demonstrated.

Let us compare a tube having a very low amplification factor to a high-mu tube having identical structures except for the number of grid turns per inch of their windings, establishing the amplification factor. Suppose that with the same high positive voltage on the plate, say 10,000 volts or higher, the negative grid potential is adjusted somewhat above the cut-off point so that the plate current is the same in both tubes. Then, in either tube the electrons will fly through the grid meshes in thin sheath formations representing a stack of electron discs co-planer with the center lines between grid turns. The presence of the longitudinal grid stays breaks up the electron discs into equal number of sectors in either tube. However, in the low-mu tube the negative potential of the stays is much higher under the specified conditions than in the high-mu tube. If we compare two extreme cases of mu equals 5 and mu equals 100, the respective negative potentials will be —2,000 and — 100 volts: the ratio is 20 to 1. Obviously, much wider gaps will be caused by the negative stays in the low-mu than in the high-mu tube. In fact, the electron discs in the low-mu tube may be converted into several sets of narrow spoke-like electron beams arranged along the center lines between the grid stays. A concentrated stream of electrons may produce local overheating of the anode wall so that the cooling water would start boiling in spots, while rest of anode remains at lower temperatures.

LAW OF HEAT DISTRIBUTION

Let us consider a cross section of the anode shown in Fig. 1. Under the condition of strong focusing effect, the narrow streams of electrons strike the anode at points A, B, C, ... We assume that the impinging electrons produce enough heat to raise and maintain the temperature at these points at the level, T_{max}, where the cooling water just starts to boil. From these points the generated heat spreads on both sides through the anode wall and, at the same time, it is transmitted to the cooling water. Obviously, the temperature, t, at any other point of the anode will be lower than the assumed maximum, T_{max}, and the lowest temperature, T_{min}, will occur at the points just half-way between adjacent hot points. With this picture in mind, we shall try to derive a law of temperature distribution throughout the anode. We shall confine our investigation to a narrow zone, p cm. wide in the direction of the tube axis, and equal in length to the distance between the points with the temperature maximum and minimum. Of course, we are justified in assuming that the temperature gradient at the coldest point is zero, as in the state of equilibrium there is no heat exchange between the adjacent symmetrical sectors of the anode. Thus, we can write our boundary conditions as follows:

$$x = 0 \qquad t = T_{max}$$

$$x_{max} = \frac{\pi r}{4} \qquad t = T_{min} \quad \text{and} \quad \frac{dt}{dx} = 0$$

The differential equation describing the heat flow in each anode sector in the state of equilibrium is:

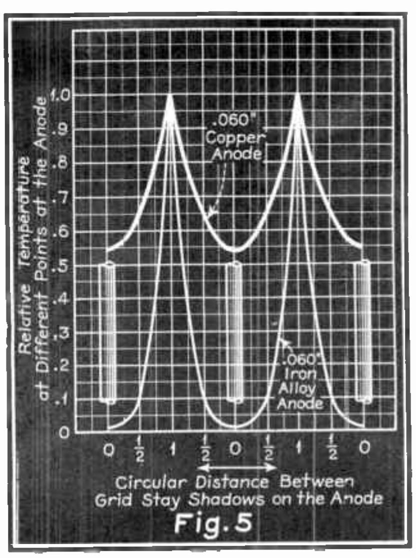
$$K\,a\,\frac{\partial^2 t}{\partial x^2}\,dx = t\,e\,p\,dx \qquad \ldots\ldots\ldots\ldots(1)$$

By e we denote here the rate of heat transfer from the anode to the cooling water, in cal./cm². 1° C: by K—heat conductivity of the anode material: by p—the width of the zone to be explored: by a—the cross section of the anode wall corresponding to the same zone: and by r—the anode radius. If, further, we designate by d the wall thickness, we can write:

$$a = pd \qquad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

The first member of eq. (1) represents the rate of heat gain by conduction due to the existing temperature

Fig. 5. Focusing effect of negative grid. Comparison of copper and iron alloy anodes.



gradient across the infinitesimal element, dx, of the zone; the second member is the rate of heat loss by the same element to the water. In the state of equilibrium both quantities are equal. The solution of eq. (1) is

$$t_x = A\varepsilon^{qx} + B\varepsilon^{-qx} \quad \ldots\ldots\ldots\ldots (3)$$

where

$$q = \sqrt{ep/Ka} \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

From the boundary conditions and eq. (3) we find:

$$T_{max} = A + B \quad \ldots\ldots\ldots\ldots\ldots\ldots (5)$$

and

$$0 = A\varepsilon^{q\frac{\pi r}{4}} - B\varepsilon^{-q\frac{\pi r}{4}} \quad \ldots\ldots\ldots\ldots (6)$$

Then, by designating

$$Q = q\frac{\pi r}{4} = \sqrt{ep/Ka}\,\frac{\pi r}{4} \quad \ldots\ldots (7)$$

we arrive at the expressions:

$$\left.\begin{aligned} A &= T_{max}\left(1 - \frac{\varepsilon^{Q}}{2\cosh Q}\right) \\ B &= T_{max}\frac{\varepsilon^{Q}}{2\cosh Q} \end{aligned}\right\} \quad \ldots\ldots (8)$$

$$t_x = T_{max}\frac{\varepsilon^{qx-Q} + \varepsilon^{-qx+Q}}{2\cosh Q} \quad \ldots\ldots (9)$$

For

$$x = \frac{\pi r}{4} \quad \text{or} \quad qx = Q \quad \ldots\ldots (10)$$

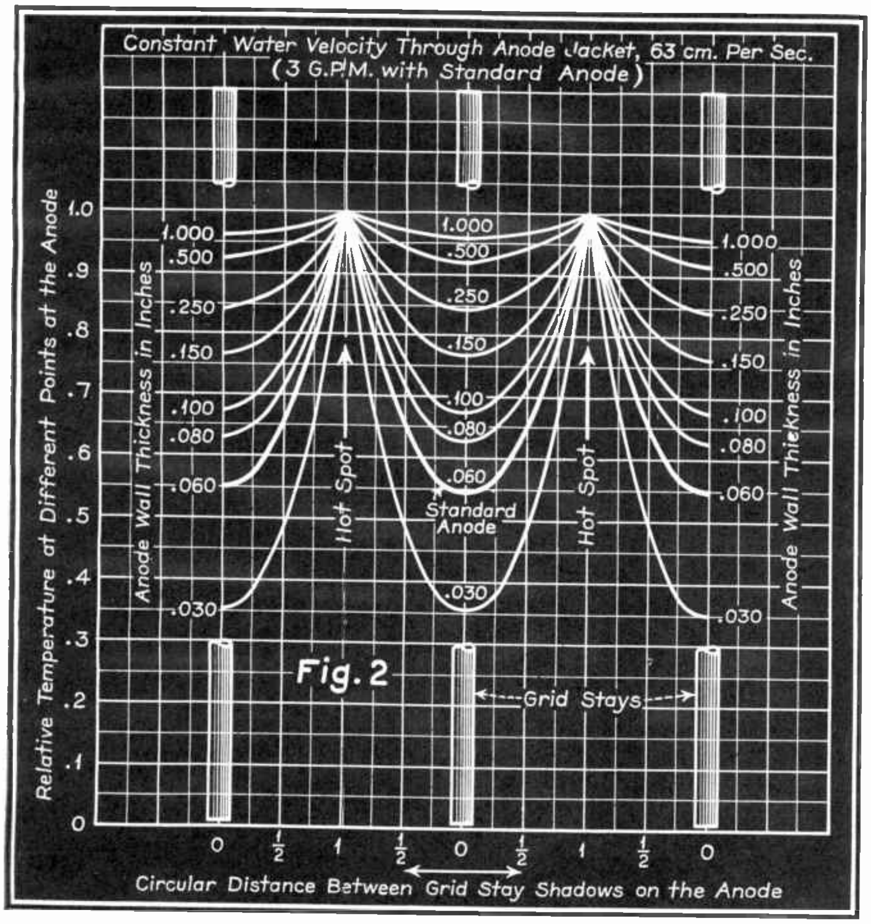
$$T_{min} = \frac{T_{max}}{\cosh\sqrt{ep/Ka}\,\frac{\pi r}{4}} = \frac{T_{max}}{\cosh\sqrt{e/Kd}\,\frac{\pi r}{4}} \quad \ldots\ldots (11)$$

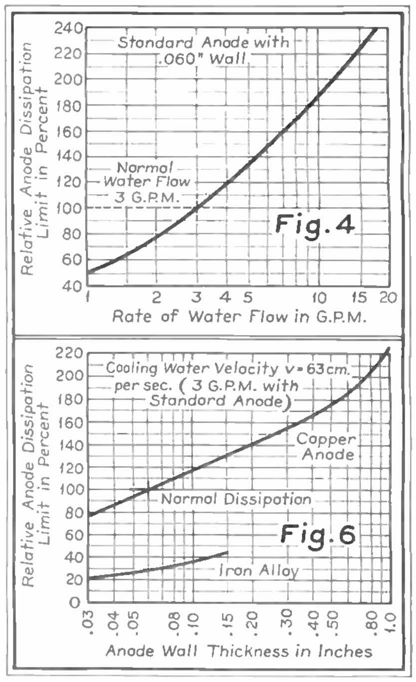
The average temperature can be derived by integrating eq. (9) over the entire zone from $x = 0$ to $x = \frac{\pi r}{4}$.

It is:

$$T_{av} = T_{max}\frac{\tanh\sqrt{ep/Ka}\,\frac{\pi r}{4}}{\sqrt{ep/Ka}\,\frac{\pi r}{4}} = T_{max}\frac{\tanh Q}{Q} \quad \ldots\ldots (12)$$

Fig. 2. Focusing effect of negative grid vs. anode wall thickness.





Focusing effect of negative grid. Fig. 4. Anode dissipation limit vs. rate of water flow. Fig. 6. Anode dissipation limit vs. anode wall thickness.

The total heat dissipated through the zone one under investigation is proportional to the average temperature, the total area of the zone, and to the heat transfer figure, e. Hence:

$$P_h = \frac{\pi r}{4}\,pe\,T_{max}\frac{\tanh Q}{Q} \quad \ldots\ldots (13)$$

$$= T_{max}\,p\sqrt{eKd}\,\tanh\sqrt{e/Kd}\,\frac{\pi r}{4} \quad . (14)$$

The last quantity, expressed in watts for the entire heater area of the anode represents the permissible plate dissipation limit for each specific heat distribution as calculated from eq. (9).

From the expressions (9), (11), (12), and (14) one can easily derive conclusions as to how the temperature distribution, the minimum and the average anode temperature, and the anode dissipation are affected by the anode thickness, d; by the rate of heat transfer, e; by the heat conductivity, k; and by the anode radius, r.

WALL THICKNESS

Numerical calculations have been carried out for anodes having inside diameter 1.5″ and wall thickness from .030″ to 1″. The results of the calculation are represented graphically in Fig. 2. The anode temperature for different wall thickness is plotted here as a function of the circular distance from the nearest shadow of the grid stay. The curves show that the thinner the anode the less uniform is the temperature distribution around the anode; this of course should have been anticipated. As a numerical example it can be mentioned that with the anode 60-mil thick and the rate of water flow, 3 gal/min the minimum temperature is only 55%, and the average temperature only 69% of the maximum temperature at the hottest point. No wonder that at this condition water starts boiling in spots, while the average temperature, and hence, the total dissipation are way below normal.

RATE OF WATER FLOW

Of great interest is the inter-relation between the temperature distribution and the figure of the heat transfer, e. The Reynolds formula in heat engineering indicates that heat transfer depends only on physical constants of the cooling fluid—water, in our case—and is proportional to the 0.8th power of water velocity. Therefore, in vacuum-tube operation the heat transfer figure can be changed by increasing or decreasing the number of gallons per minute fed through the water-jacket. It may be noted that this is the only quantity in the hands of the tube operator; all other factors are tube design constants.

Fig. 3 shows temperature distribution for the anode of a constant wall thickness at variable rate of water flow. We see that the *more water* we send through the jacket the *less* uniform becomes the temperature distribution. Therefore, an increased figure of heat transfer as a result of a higher water velocity is counter-acted by a drop in average temperature. The derived expression (14) for plate dissipation permits the conclusion that the dissipation limit increases proportionally only to 0.4th power of water velocity.

Temperature distribution in wall of circular tube.

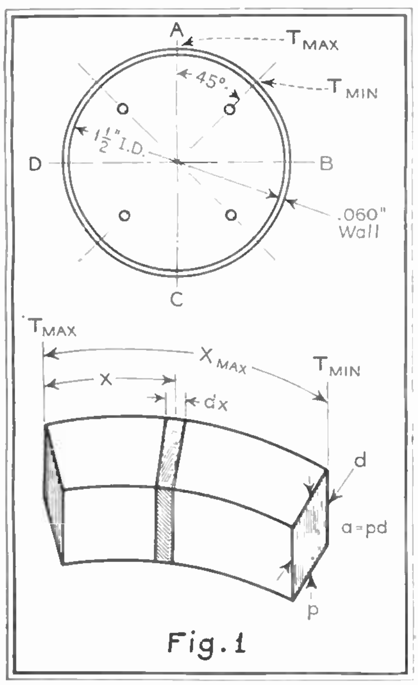
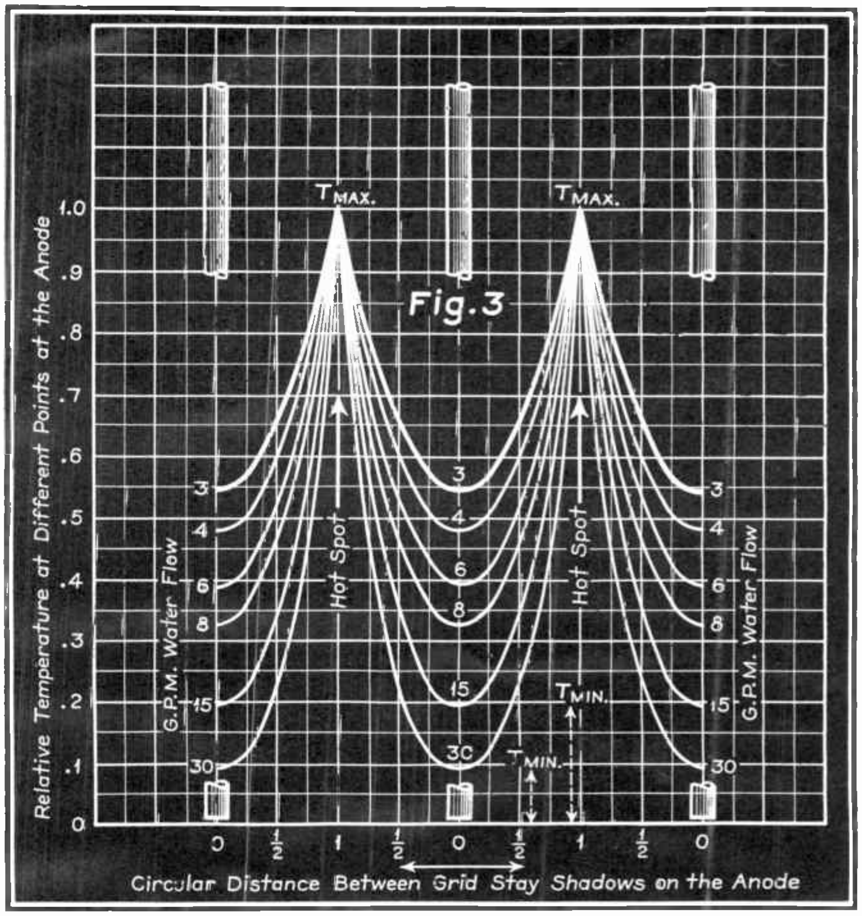


Fig. 1



Focusing effect of negative grid vs. rate of water flow.

In Fig. 4 anode dissipation is plotted as a function of the rate of water-flow. For a better illustration of what has just been said about effect of the increased water-flow, let us imagine that an operator finds that his tube "boils" badly. He wishes to improve drastically the cooling condition of the anode and increases the rate of water-flow 5 times, say from 3 to 15 gal/min. He perhaps feels that the anode dissipating capacity is also improved in the same ratio. This is wrong, as our curve shows that by increasing the flow from 3 to 15 gallons the gain in dissipation is only slightly more than two times.

HEAT CONDUCTIVITY

The third factor affecting the temperature distribution is *heat conductivity* of the anode material. If instead of copper the anode is made of chromium-iron, or of iron-nickel alloy with heat conductivity approx. 1/20 of that of copper, the temperature distribution becomes strikingly less uniform than with copper anodes of the same thickness and with the same rate of water-flow. This is illustrated by Fig. 5.

Fig. 6 represents anode dissipation as a function of the anode thickness both for a copper and iron-alloy anodes of the same thickness. The curves speak for themselves.

ANODE RADIUS

Finally, let us consider the following case. Without changing any detail in the design, a vacuum tube is simply magnified in the radial direction in the ratio 2:1, except for the anode thickness. The average temperature calculated from the expression (12) is now equal to 0.41 T_{max} instead of 0.69 T_{max} with the original small anode. At the same time, the anode dissipation (calculated from eq. 14) increases in proportion only 1:1.19, in spite of the double cooling area of the anode. In order to double also the anode dissipation figure with the respect to the original anode, the average temperature must be brought up to its former level, 69% of the temperature maximum. The calculation shows that this can be done by making the anode wall 4 times as thick as it was originally.

In conclusion it must be noted that the basic differential equation was writ-

(*Continued on page 27*)

A CONTINUOUSLY VARIABLE

By C. B. AIKEN

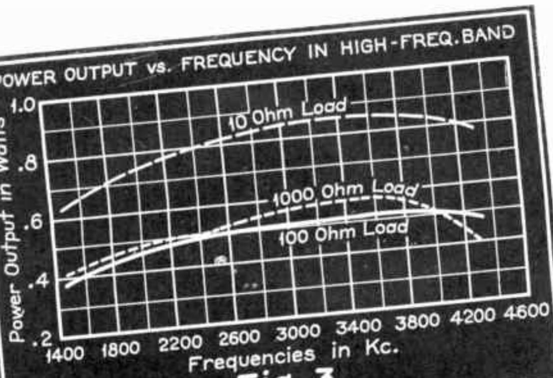


Fig. 3

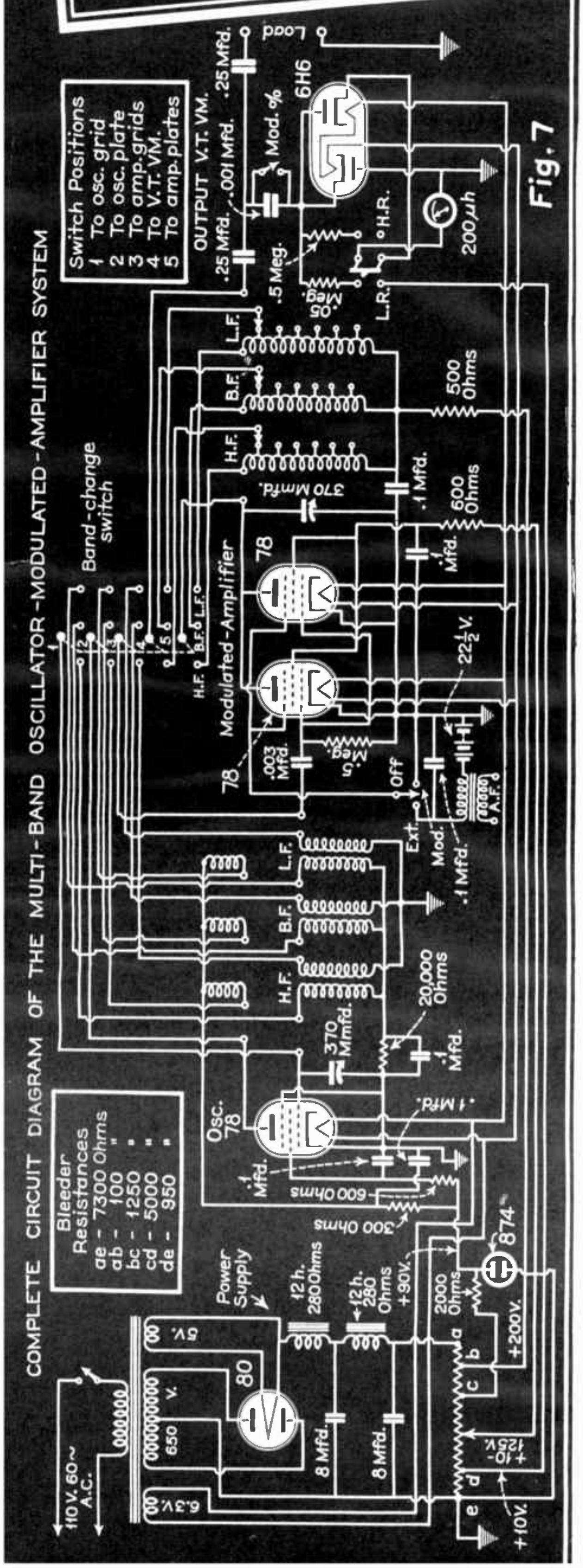


Fig. 7

THE OUTSTANDING limitation of the standard signal generator is its small output. At most, this is about two volts into a high-impedance load, and is considerably less with some models. Very often, there is need in the laboratory for a generator capable of delivering several volts into loads of moderate impedance. Such a unit should have the tuning flexibility of the standard signal generator, a-c operation, good frequency stability unaffected by the load which is connected to it and by line-voltage fluctuations, and should have arrangements for modulating its output. It is the purpose of this paper to describe a unit meeting these specifications which has been developed for use in the laboratories of Purdue University.

CHOICE OF TUBES FOR THE AMPLIFIER

A power tube capable of delivering several watts naturally suggests itself for use in the output stage of the generator. However, if anything like the rated output is to be obtained from such a tube, it must work into an impedance which is reasonably near the proper value, and must be supplied with ample r-f driving power. If the generator is to be tuned quickly from one frequency to another and if loads of widely differing magnitudes are to be connected to the output, it is very difficult to maintain proper operating conditions for the power amplifier. Unless we sacrifice simplicity of adjustment, we cannot expect to obtain a power over the whole tuning range of more than a small fraction of the rated output of the tube. Furthermore, the grid current which is drawn by a tube of a few watts rating is large enough to throw a considerable load on the tube which drives it. The grid current is greatly affected by the impedance into which the power tube works, and consequently the load thrown upon the driver is a function of the tuning of the output tank circuit, and is also dependent upon the load impedance which the generator feeds. This means that a buffer stage must be used between the oscillator and the power tube, if high frequency stability is to be secured. Such a stage requires an additional tuning control, as well as extra tuning coils.

Because of these objections, it was decided to use two small receiver-type tubes in parallel in the output stage. This resulted in a tremendous reduction in grid current, and also made it possible to employ a power supply of lower voltage and smaller current capacity. Experimental work showed that type-78 tubes function very satisfactorily in this manner, and many performance data were taken.

Fig. 1 shows the output power into three different load resistances that was obtained with one, two and three type 78's. An ordinary receiver-type tuning condenser was used in the tank circuit, and it may be seen that a very satisfactory tuning range is possible with one and two tubes. With three tubes, this range was cut down somewhat (although not quite as much as indicated in the figure), due to the extra capacity. In taking these data, a tank-circuit coil provided with taps was used, and the tap which gave maximum output was chosen for each measurement made. It may be seen that, with two tubes, a power output of 0.6 watt or more can be obtained over a range of load resistance of 100 to 1. It was also found that very useful outputs could be had with loads of 1 ohm and of 3000 ohms.

MODULATION OF THE OUTPUT STAGE

In deciding upon a method of modulation, it was necessary to choose between (a) high modulation capability without reduction in power, which would require ample power in the audio-modulator, and (b) reduced modulation capability accompanied by a reduction in carrier output, necessitating only a very small amount of modulating power. (a) is perfectly feasible, since, when the modulating voltage is applied to both plate and screen of the 78, very good linear characteristics can be obtained. However, this would require some increase in the r-f driving power, which is undesirable, and also calls for ample power in the audio-modulator. It was therefore decided to adopt the second compromise, and to apply the modulating voltage, in series with a negative bias, to the suppressor. This bias, of course, cuts down the carrier output, and the linear range of the modulation characteristic is not as great as we might wish, but is enough to permit 30% modulation.

Fig. 4 shows the r-f output versus suppressor-grid voltage for frequencies

RADIO-FREQUENCY OSCILLATOR

and I. L. LIU

of 300, 1000 and 3000 kc. Fig. 5 shows the effect of change in load resistance on the modulation characteristic, while Fig. 6 shows the effect of two different types of gain control. The solid lines in this last figure indicate the characteristics obtained with various screen voltages and a zero added grid bias. (There is, of course, a drop across the grid-leak resistance.) The dotted lines indicate the effect of using a fixed screen-grid voltage and changing the control-grid bias. It is to be noted that when the screen-grid control is used, a suppressor bias of 22.5 volts allows a reasonable voltage swing in both directions over a wide range of outputs. In other words, it is possible to properly modulate the stage over a considerable range of amplification adjustment. The use of variable screen-grid voltage together with taps on the output coil makes it possible to vary the output voltage over a range wide enough for most purposes.

THE COMPLETE UNIT

The unit which was finally built has three bands, covering the intervals from 195 to 570 kc. from 525 to 1535 kc. and 1450 to 4440 kc. The oscillator and power amplifier are switched by a multi-pole, three-position rotary switch, and separate tuning condensers are used for the oscillator and for the power stage. This last is necessary, since the tuning of the power stage is affected by the load connected to the output terminals. A single type 78 is used for the oscillator, and two type 78's in parallel for the amplifier.

The power output in the low-frequency band for three different load resistances is shown in Fig. 2, and for the high-frequency band in Fig. 3. The broadcast band output is as illustrated in Fig. 1 for the case of two tubes.

A high value of grid-leak resistance is used in the input to the power stage in order that the grid current may be kept small. Actually, this current is less than 45 microamperes at all frequencies, and consequently the load placed upon the oscillator is extremely light. This results in very satisfactory frequency stability. In the broadcast band, the maximum shift in the oscillator frequency which can be produced by changing the load and tuning of the output tank circuit is less than 0.1 percent, and the stability is of the same order of magnitude in the other bands.

To avoid frequency changes due to fluctuations in a-c supply voltage, the oscillator is operated at 90 volts, obtained from a type-874 regulator tube. This is very effective, and a change in line voltage from 105 to 125 volts causes a frequency shift in any band of less than 0.01 percent. Most of the change which does occur seems to be associated with alteration of the filament temperature, since it happens gradually after the change in supply voltage has been made.

The circuit diagram of the complete oscillator-amplifier is shown in Fig. 7. Each output coil has eleven taps, the number of turns for each tap being different for the three different ranges. The maximum number of turns that can be included in the output load is eighty for the low-frequency band and eighteen for the high-frequency band. No effort is made to exactly calibrate the output tuned circuit, since the effect of the load on the tuning is too great. However, the oscillator tuning is independent of load conditions, and its dial is therefore calibrated directly in kilocycles. The use of a tuned circuit in the amplifier output makes the waveform better than that furnished by many ordinary signal generators.

THE OUTPUT VACUUM TUBE VOLTMETER

A somewhat novel vacuum-tube voltmeter is incorporated in the generator. This utilizes one of the diodes of a 6H6 in a conventional grid leak-detector circuit, while the other diode is used as an overload protector for the sensitive range. When the half-megohm rectifier is used, it is not possible to supply enough voltage to damage the meter, but the sensitivity is not high enough to permit the measurement of small outputs. A 50,000-ohm resistance is therefore supplied, which may be selected by a switch, and with this low resistance in circuit the sensitivity is, of course, greatly increased. In order to make it impossible to damage the meter when the high-sensitivity range is used, the extra diode is connected across the main rectifier with reverse polarity and with a delay bias of 10 volts. The result is that, no matter how large a voltage is impressed upon the voltmeter, the cur-

(*Continued on page 27*)

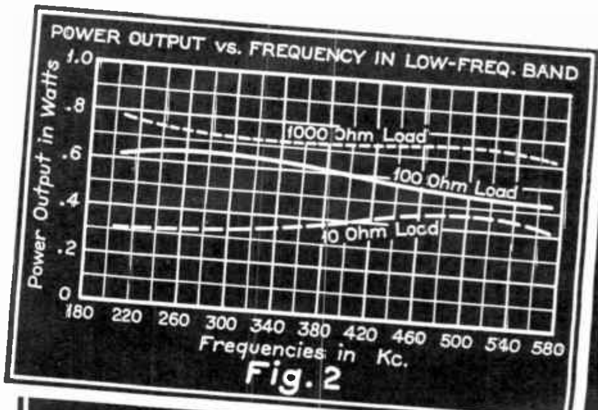


Fig. 2

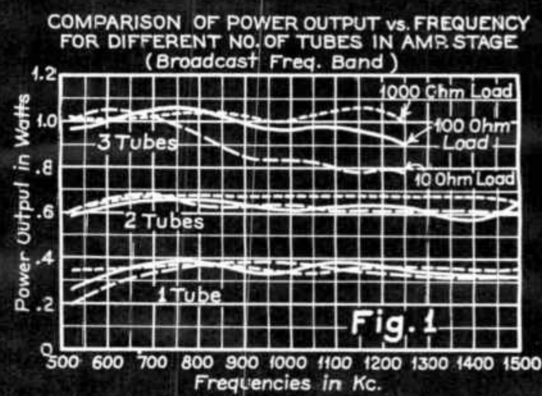


Fig. 1

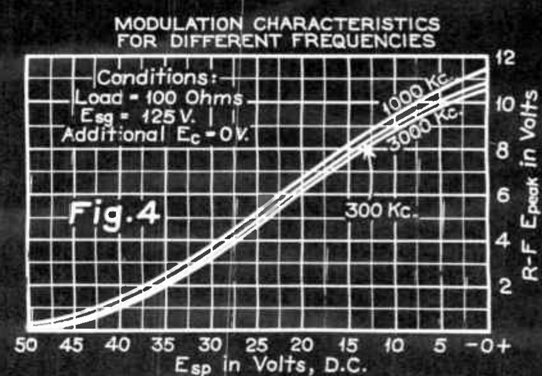


Fig. 4

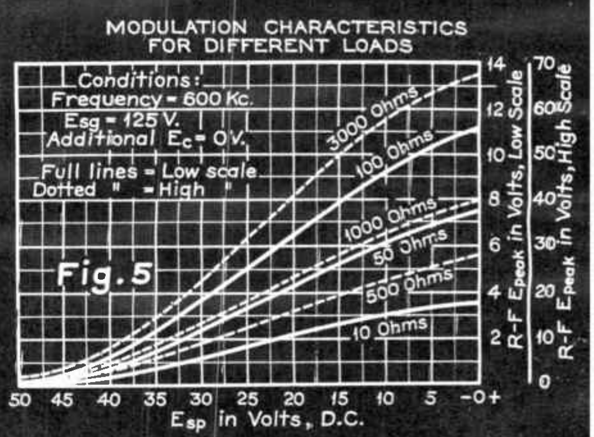


Fig. 5

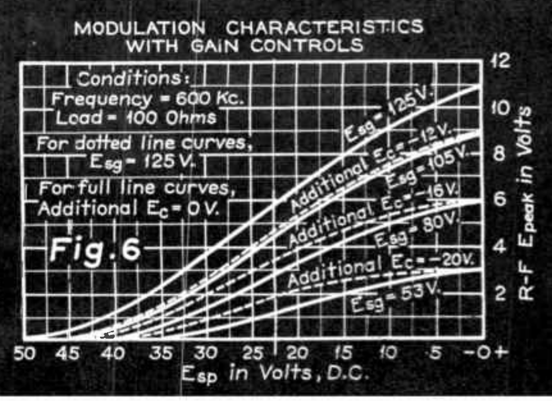


Fig. 6

TELEVISION

By ALBERT F. MURRAY
Acting Chairman
RMA TELEVISION COMMITTEE
Engineer in Charge of Television
PHILCO RADIO & TELEVISION CORP.

Albert F. Murray, the author.

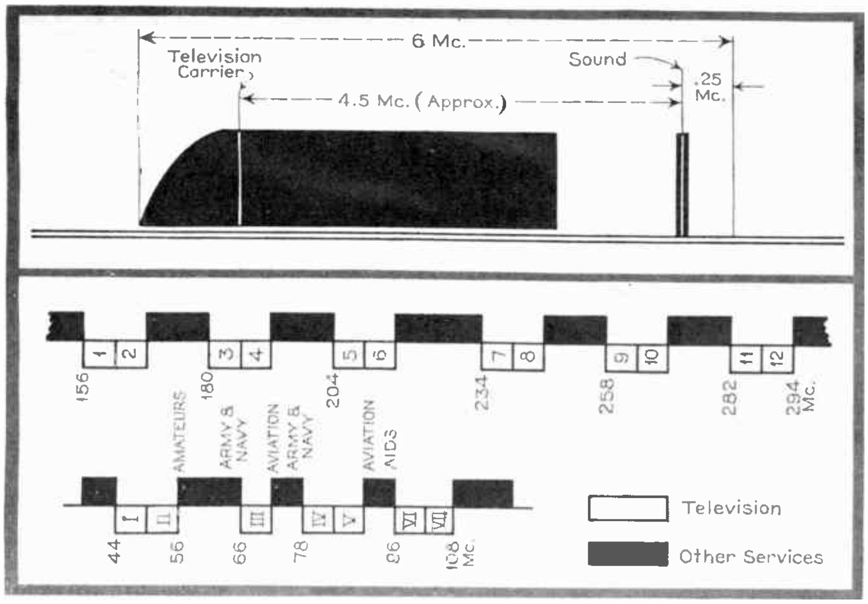
LATE ONE afternoon in 1930, in a meeting room in Hotel Astor, New York City, a small group of television men, forming the RMA Television Committee, were earnestly debating the possibility of standardizing 60-line scanning. These men represented companies such as: Short Wave and Television Corp., of Boston; American Baird, New York City; Sanabria, Chicago; Hogan, New York City; Bell Telephone Laboratories, New York City; RCA, New York; RCA-Victor Company, Camden; Philco, Philadelphia; Jenkins Television Corp., Jersey City. Connected with the latter corporation was our able chairman, D. E. Replogle.

In 1938 we look back and wonder why only eight short years ago we believed 60-line pictures acceptable, when now we are using 441-line scanning. We wonder, also, as we read the list of television companies mentioned, what has become of some of them. What will be the fate of our television industry at the end of another eight years? No one knows. It may be referred to as "an infant industry," but it will possess the advantage of more than a decade of specialized engineering experience. Few industries can boast of so much *pre-commercial* laboratory and field testing and experimentation. We expect, therefore, that when ready for the market the product should be highly perfected—before it enters the customer's home. Certainly with so much experience we should be able to avoid the early mistakes of sound broadcasting.

Unknown to the man in the street—and almost unknown to the engineering fraternity because of its confidential nature—has been the engineering progress in about a half-dozen television laboratories. Highly trained researchers are busy improving transmission, reception and utilization of the fleeting images, the reproduction of which in the American home will some day be a major industry, built upon the union of communication and visual entertainment.

Radio manufacturers have come to appreciate more and more the importance of the formation of television standards for the U. S. *before* commercial television arrives. Imagine the situation if

Upper: Fig. 1. Typical television chanel (single-sideband). Lower: Fig. 3. Chart of television frequency assignments.



PROPOSED STANDARDS

(AS OF JULY, 1938)

T-101 TELEVISION CHANNEL WIDTH
The standard television channel shall not be less than 6 megacycles in width.

T-102 TELEVISION AND SOUND CARRIER SPACING
It shall be standard to separate the sound and picture carriers by approximately 4.5 mc. This standard shall go into effect just as soon as "single side band" operation at the transmitter is practicable. (The previous standard of approximately 3.25 mc. shall be superseded.)

T-103 SOUND CARRIER AND TELEVISION RELATION
It shall be standard in a television channel to place the sound carrier at a higher frequency than the television carrier.

T-104 POSITION OF SOUND CARRIER
It shall be standard to locate the sound carrier for a television channel 0.25 Mc. lower than the upper frequency limit of the channel.

T-105 POLARITY OF TRANSMISSION
It shall be standard for a decrease in initial light intensity to cause an increase in the radiated power (See Standard M9-121).

T-106 FRAME FREQUENCY
It shall be standard to use a frame frequency of 30 per second and a field frequency of 60 per second, interlaced.

T-107 NUMBER OF LINES PER FRAME
It shall be standard to use 441 lines per frame.

T-108 ASPECT RATIO
The standard picture aspect ratio shall be 4:3.

T-109 PERCENTAGE OF TELEVISION SIGNAL DEVOTED TO SYNCHRONIZATION
If the peak amplitude of the radio frequency television signal is taken as 100%, it shall be standard to use not less than 20% nor more than 25% of the total amplitude for synchronizing pulses.

T-110 METHOD OF TRANSMISSION
It shall be standard in television transmission that black shall be represented by a definite carrier level independent of light and shade in the picture.

T-111 SYNCHRONIZING
The standard synchronizing signals shall be as shown on Drawing T-111.

T-112 TRANSMITTER MODULATION CAPABILITY
If the peak amplitude of the radio frequency television signal is taken as 100%, it shall be standard for the signal amplitude to drop to 25% or less of peak amplitude for maximum white.

T-113—TRANSMITTER OUTPUT RATING
It shall be standard, in order to correspond as nearly as possible to equivalent rating of sound transmitters, that the power of television picture transmitters be nominally rated at the output terminals in peak power divided by four.

T-114—RELATIVE RADIATED POWER FOR PICTURE AND FOR SOUND
It shall be standard to have the radiated power for the picture approximately the same as for sound.

STANDARDS

COMMENT

T-101 Already approved by the FCC. This band width appears to be the optimum considering picture detail and the available spectrum. Channels twice this width should be available for future research in the 156-294 mc region.

T-102 Single-sideband operation is demanded if a high-fidelity 441-line picture is to be transmitted in a 6-mc channel. The spacing of "approximately 4.5 mc" has been stretched to 4.75 mc. in the proposed single-sideband experiments of RCA-NBC in New York and by CBS. It is also the spacing used by Philco in single-sideband experiments now being broadcast in Philadelphia. (Sept. 1938)

T-103 See Fig. 1.

T-104 See Fig. 1.

T-105 Negative transmission (or modulation). Permits simply designed automatic gain control.

T-106 Chosen because most power supplies are 60 cycle, thus hum difficulties are minimized. No flicker. Interlace ratio of 2:1 does not noticeably impair picture quality.

T-107 Approximately the optimum number of lines considering picture detail and channel width. Exact number 441 chosen because it has simple factors 7x7x3x3. This simplifies the design of synchronizing generators.

T-108 Standard motion picture practice.

T-109 Television receiver designers require this standard.

T-110 Title should be "Transmission of Black Level." It is important to maintain this reference level of black, shown in Fig. 2.

T-111 See Appendix.

T-112 A transmitter performance standard.

T-113—Television transmitter power is often given in terms of *peak* output. Standard T-113, however, fixes a rating method identical with that of sound transmitters.

T-114 A transmitter performance standard. Also tells receiver designer what relative sound field strength to expect.

RMA Subcommittee on Television Standards

Representative, Company and Alternate

P. C. Goldmark—Columbia Broadcasting Co.
P. T. Farnsworth—Farnsworth Television—P. J. Herbst
I. J. Karr—General Electric Co.—R. B. Dome
H. M. Lewis—Hazeltine Service Corp.—D. E. Harnett
R. M. Morris—National Broadcasting Co.
E. W. Engstrom—RCA Manufacturing Co.—R. D. Kell
A. F. Murray, Ch.—Philco Radio & Television—F. J. Bingley

A discussion of the proposed RMA Television Standards for the U. S. A.

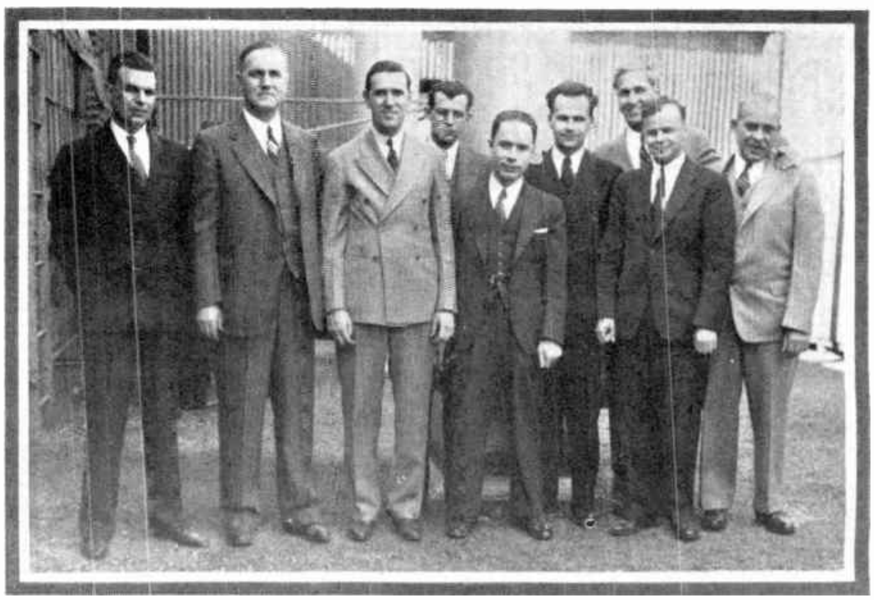
Photo of 441-line television image. Courtesy Philco.

receivers built in Chicago would fail to operate from transmitters located in New York. What would happen if various companies were busily turning out television receivers and there were no accepted transmission standards. The result would be chaos!

As a forerunner of Great Britain's commercial television program, the British Postoffice appointed a television committee, headed by Lord Selsden, to investigate the entire television situation. They visited Germany and the United States. Confidential laboratories were opened to them. They observed demonstrations and asked questions. Upon their return to England they formulated standards for British television. In November, 1936, the British Broadcasting Corporation inaugurated a high-definition commercial service based on these standards. Unfortunately two sets of standards were approved, instead of a single standard as demanded in the U. S., but after months of side-by-side comparison the present 405-line interlaced system was the one selected for use in England. An official promise that this standard will be unchanged for at least two years guards against this cause of early receiver obsolescence.

In the U. S. the Radio Manufacturers Association, through their Television Committee (membership list on next page), have been working steadily toward the goal of a single set of television standards. Through the years, in the committee there have been changes in the companies represented, in the members, and, most of all, in the ideas of what constitutes an acceptable picture. In 1935 there was appointed a group of television engineers to form the RMA Subcommittee on Television Standards. From the personnel list below it will be seen that representatives are not restricted to RMA member companies. Recommended standards are sent to the main committee for approval, then to the RMA Section's Head, V. M. Graham, to be voted upon by the entire RMA membership. Next, they

RMA Subcommittee: (left to right) Somers, Harnett, Bingley, Kell, Karr, Goldmark, Murray, Engstrom, Lewis.



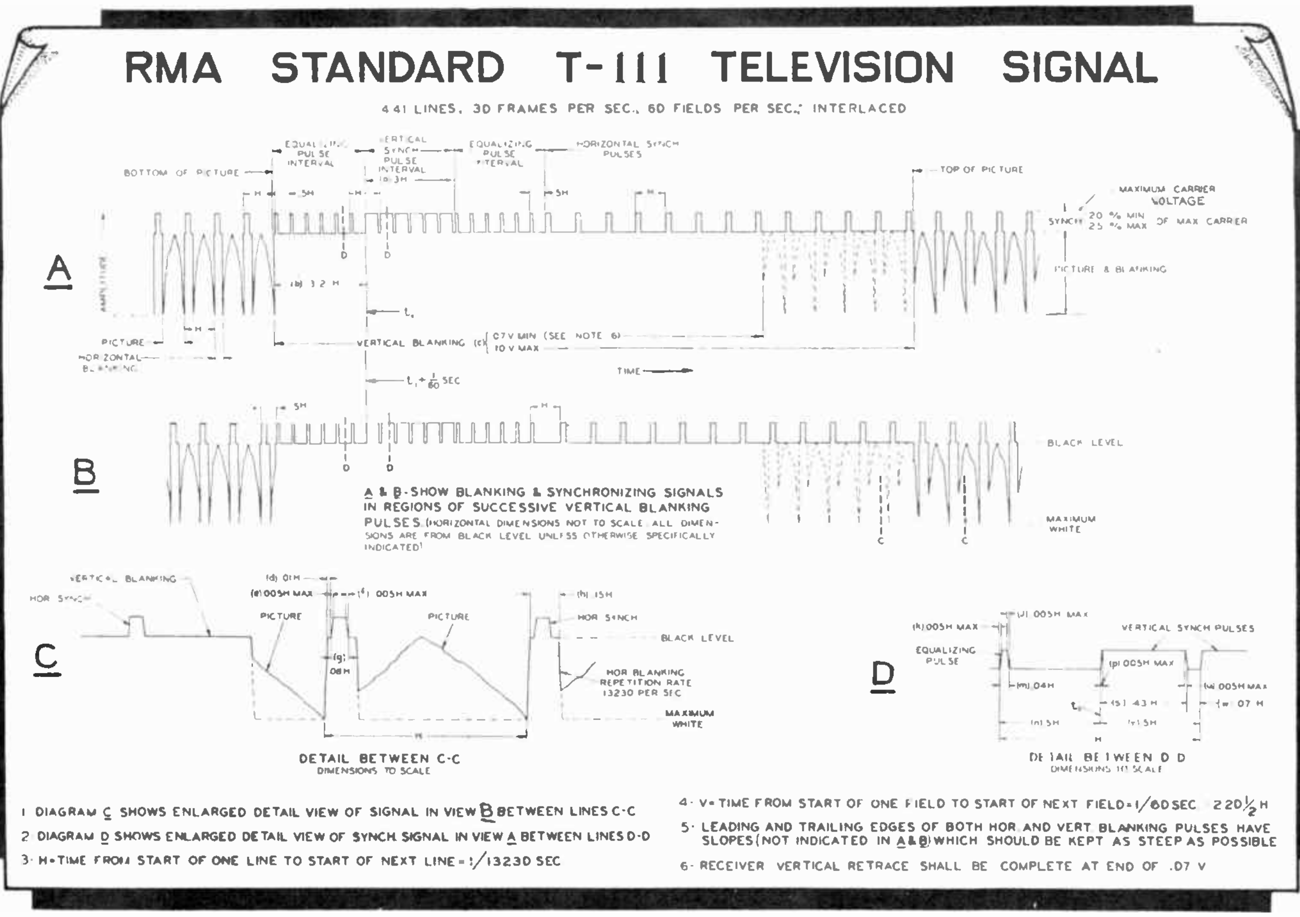


Fig. 2. RMA synchronizing signal.

are placed before the Board of Directors by W. R. G. Baker, Director of Engineering. After approval they are formally presented to the Federal Communications Commission.

With this outline of committee set-up as a background we next glimpse at the functioning of the group who initiate the standards. An inspection of the membership of the Sub-committee indicates that a number of the companies are competitive. Several operate confidential laboratories around which safeguards were placed to prevent television information from reaching competitors. It was interesting, indeed, to see what would happen during the first few meetings of the Committee. It was found that regardless of keen company rivalry, the various television representatives manifest toward one another a feeling of friendliness rather than antagonism. We could not help from feeling that, being brother experimenters in a new and intensely interesting field, we belonged in a sense to the same fraternity—the television fraternity.

As we got to know each other better, as more and more technical information found its way into print, and as secrecy restrictions were lifted here and there, we began to make progress. We could understandingly discuss details of various television systems and draw engineering conclusions leading toward the recommendation of standards—standards that will be best, we believe, for the interests in the entire industry.

Now, as in the past, the cooperation among the members is to be highly commended. Naturally there are differences of opinion. Some companies willingly make concessions where it is best this be done for the common good.

In order for RMA to present recommended frequency assignments for television to the Federal Communications Commission at the ultra-short wave hearing in Washington, June 15, 1936, recommendations for channel width (6 megacycles), number of lines (441), and other vital television standards, had to be decided prior to that date. At the specified time the RMA Television Committee publicly presented their recommendations. These were, to a great measure, responsible for the FCC assigning channels 6-mc wide for experimental television. The standards recommended at this time were substantially those listed as T-101, T-103 to T-108.

To get competing television interests to agree to a single set of standards, and to agree *unanimously* took a considerable amount of negotiation. In fact, some of the RMA Board Members said they were surprised, and pleased, that the Committee could achieve a unanimity of opinion. The writer deeply appreciates the cooperation of the members which made possible this result.

(*Continued on page 28*)

RMA TELEVISION COMMITTEE

Group 1. MEMBERS

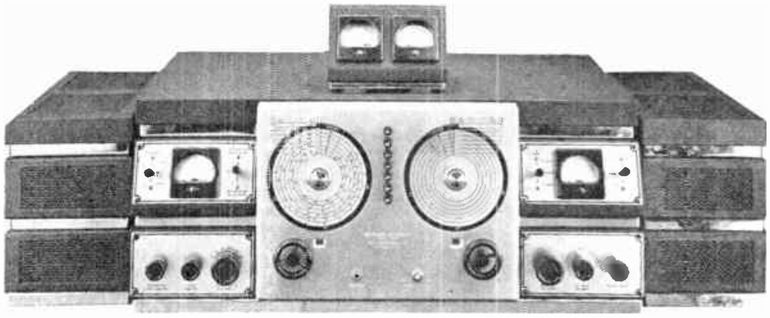
Name	Company
J. E. Brown	Zenith Radio Corp.
R. D. Brown	Philadelphia Storage Battery Co.
I. J. Kaar	General Electric Co.
E. W. Engstrom	RCA Mfg. Co.
H. M. Lewis	Hazeltine Serv. Corp.
R. H. Manson	Stromberg-Carlson Tel. Mfg. Co.
H. V. Nielsen	Sparks Withington Co.
H. J. Tyzzer	Crosley Radio Corp.

Group 2. INVITED MEMBERS (not representing RMA Member Companies)

R. Bown	Bell Telephone Labs.
P. C. Goldmark	Columbia B'dc't'g Sys.
A. N. Goldsmith	
J. V. L. Hogan	Radio Pictures
R. M. Morris	Nat. B'dc't'g Co., Inc.
A. F. Murray (Ch.)	Philco Radio & Television Corp.
P. T. Farnsworth	Farnsworth Tel., Inc.

Group 3. GUESTS

T. A. M. Craven	Fed. Com. Commission
Gerald Gross	Fed. Com. Commission
R. A. Hackbusch	RMA of Canada
E. K. Jett	Fed. Com. Commission
A. F. VanDyck	RCA Licensee Labs.



The universal diversity receiver.

A UNIVERSAL DIVERSITY RECEIVER

By S. GORDON TAYLOR

WITH THE INTRODUCTION to the general market of a receiver that combines diversity action with other refinements in a single unit of compact size and moderate cost, there is every reason to believe that the advantages of the diversity principle of reception will no longer be limited to the large commercial stations. The high cost of developing diversity apparatus for individual installations has up to now been a deterring influence, but with the introduction of production equipment this obstacle seems to be overcome.

It is believed that a description of this new Hallicrafters Model DD-1, dual-diversity receiver will be of more than passing interest, representing as it does the first attempt on the part of a manufacturer to provide diversity equipment in a form practical for all types of services.

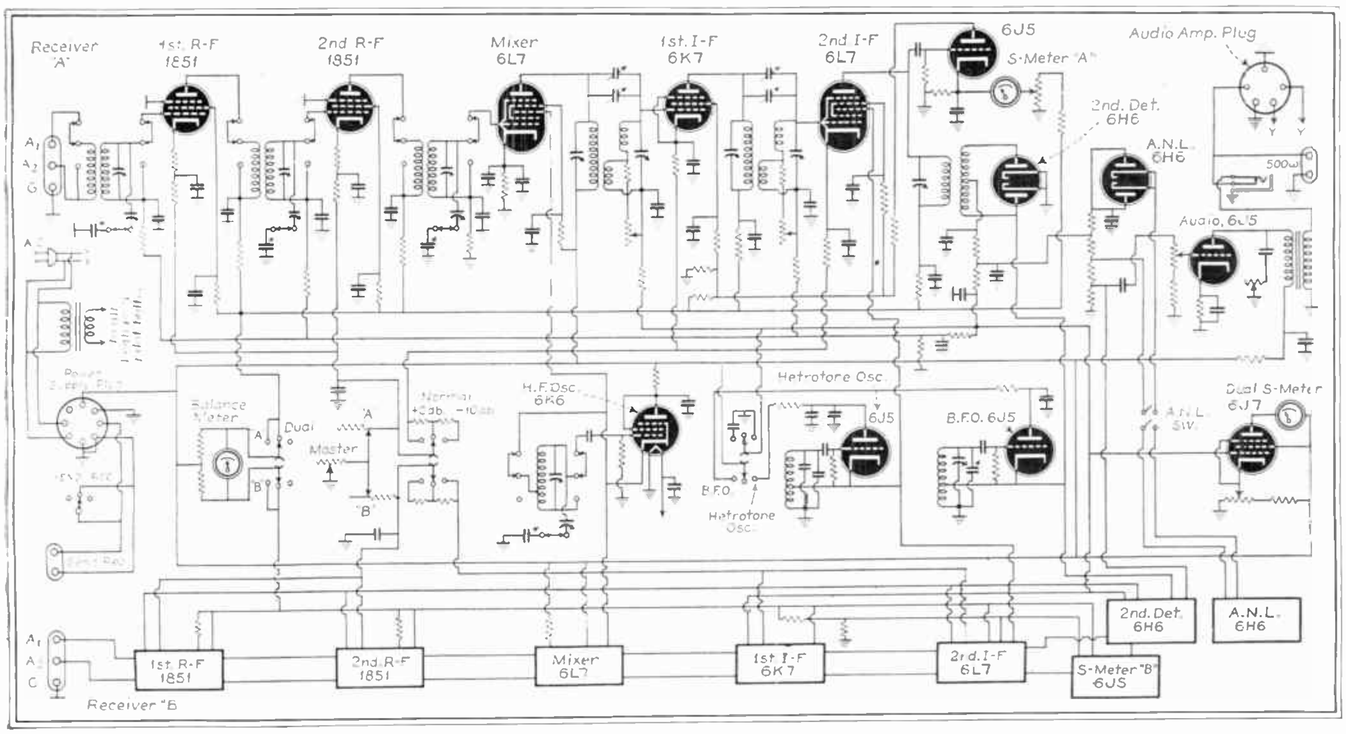
The receiver, as illustrated in the accompanying photographs, consists of the tuner flanked at either end with the separate power supply and power-amplifier units. The tuner dimensions are approximately 30 inches wide, 11 inches high and 19 inches deep. The other two units are each 7½ inches wide, 11 inches high and 16½ inches deep.

The tuner contains two separate and identical 8-tube superheterodynes which feed into a common audio channel. Each provides continuous and simultaneous coverage of a frequency range extending from 540 kc to 46 mc, in six bands, selected by push-buttons.

An outstanding and unique feature of the tuner is the use of a single r-f oscillator common to both channels. The use of a common r-f oscillator results in appreciable economies in both size and cost, made possible because of the less stringent shielding and buffer requirements. Also the dual-diversity model tunes both channels simultaneously by means of a single dial; a feature which is invaluable to many types of service where more or less constant tuning from one frequency to another is necessary.

Two tuning controls and dials appear on the face of the tuner. One of these,

Circuit diagram of the diversity receiver. Receiver channel "B" is shown in block form, since it is identical with "A."



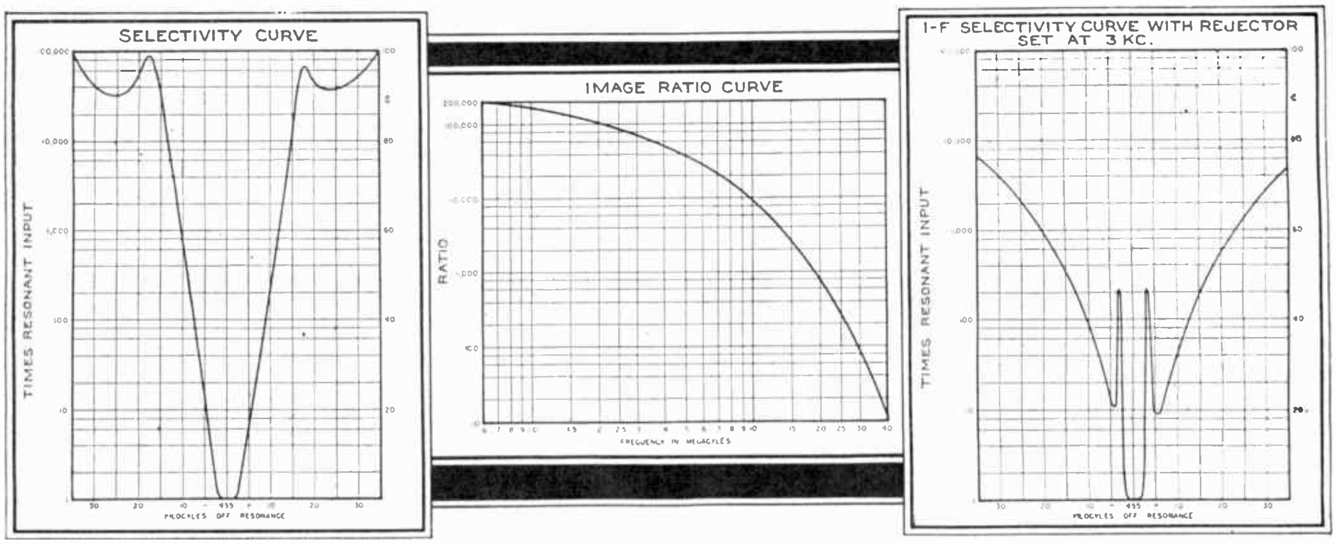


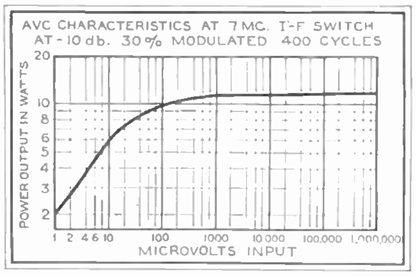
Image ratio and selectivity curves for the universol diversity receiver.

fully calibrated in frequency, is the main range-setting dial; the other provides wide band-spreading in this selected range. This electro-mechanical band-spread system results in non-critical tuning, even in the ultra-high-frequency ranges, and operates in any portion of any tuning range.

In addition to single-control tuning, a number of other controls are ganged for simultaneous adjustment of both channels. These include r-f gain, i-f gain, the infinite adjacent-channel-interference rejector, stand-by switch and noise-limiter switch. The r-f gain is also adjustable for the individual channels. This is accomplished by a dual resistor and serves as a balancing adjustment. In its mid-position the gain of the two channels is equal but as it is rotated to the right from this position the gain of channel "A" is increased and "B" decreased. Turned to the left the opposite action is obtained. In this way differences in effective average pick-up of the two antennas are readily compensated and fullest advantage taken of the diversity action.

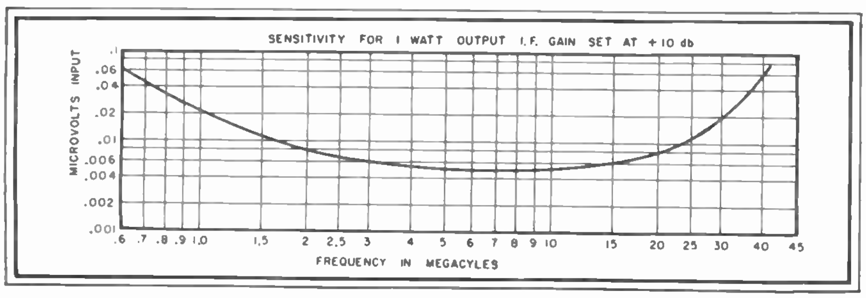
The audio channel, beat-frequency oscillator and "heterotone" oscillator circuits are common to both channels and their individual controls therefore function simultaneously with both.

Two meters are built into the tuner. The one shown at the left is the overall "S," or carrier-level indicator, which functions on the combined output of the two channels. At the right is the "balance" meter which aids in the adjustment of individual channel r-f gain, and which shows the relative effectiveness of the two antennas when compensating adjustment is required. As optional equipment the meter unit shown on top of the tuner is available. This plugs into a receptacle provided in the rear of the tuner housing and includes an "S" meter for each channel. This device is particularly interesting as it shows the fading variations of the signal in each channel and by observing these two and the overall "S" meter at the same time the effectiveness of the diversity action is easily demonstrated. This is a material aid in determining the proper placement of the antennas for maximum diversity effectiveness.



Above: Curve giving the avc characteristic at 7 mc.

Below: Sensitivity curve for the receiver.



A three-position switch permits either receiver channel to be used alone, or the two in combination. Thus if the two antennas employed have different directional properties, interference from a direction other than that of the desired signal may be minimized by using the channel that favors the desired signal, cutting out the one through which the interference signal predominates.

The functional diagram of the tuner is presented. It has been considered sufficient to show receiver channel "B" in block form inasmuch as it is identical with channel "A." For the same reason the following brief discussion will be limited to one channel and the circuits common to both.

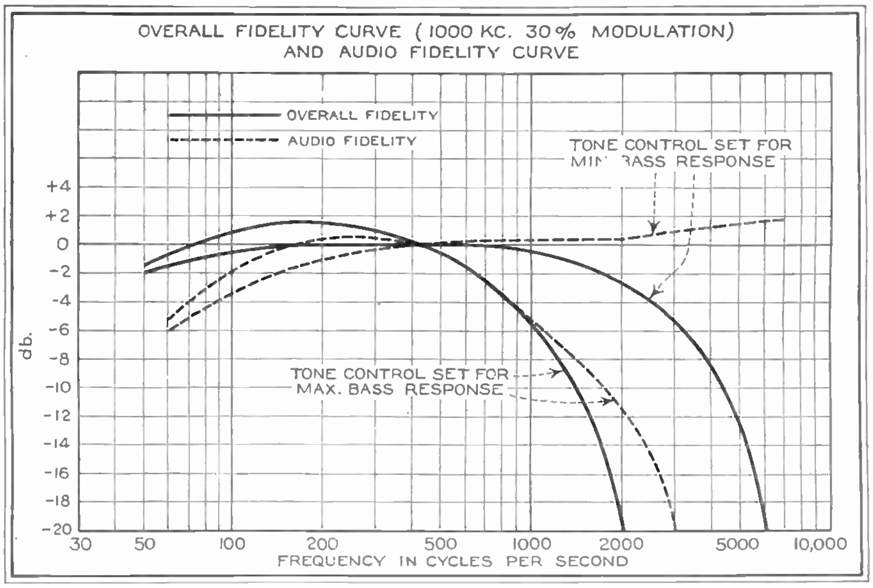
Two stages of tuned r-f amplification are employed. These utilize the new 1851 tubes not only for their general high-gain characteristics, but particularly for their advantages in maintaining this gain throughout the ultra-high-frequency ranges. This high gain is advantageous from the standpoints of both effective sensitivity and improved automatic gain control. Also the use of two stages, with an intermediate frequency of 455 kc, provides a highly favorable degree of image selectivity.

The 6L7 mixer circuit is conventional, but not so the common r-f oscillator. This employs a 6K6 power tube to permit the parallel mixers to be connected into its cathode circuit where the unusually large capacitative load has less limiting effect on the oscillator tuning range.

The two-stage i-f amplifier offers two somewhat unconventional features. The first is the coupling system which constitutes the "infinite adjacent-channel interference rejector." In this system both inductive and capacitative coupling are utilized but so arranged that at some frequency close to resonance these two types buck each other and cancel out interference that may exist at this adjacent frequency. By varying the coupling capacity this cancellation may be made to occur at any frequency from 3 to 18 kc off resonance. Thus an interfering signal anywhere in this range can be effectively dropped out without reduction of the desired signal. The coupling capacity is varied by means of a control on the front panel and to this the i-f systems of both channels are ganged.

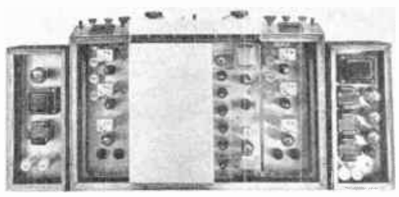
The second feature of the i-f amplifier is the use of a 6L7 in the second stage. This is done to utilize its injector grid as a means for feeding in the 1,000-cycle output of the common 6J5 "heterotone" oscillator for tone modulations of cw signals and unmodulated carriers. When a beat-frequency oscillator is used for this purpose it tends to affect receiver sensitivity through its reaction on the agc system, particularly when receiving weak signals. Also the beat-note intensity varies widely with signal strength. The "heterotone" oscillator overcomes these difficulties completely and this is fortunate because it permits cw reception with the agc system functioning, without which diversity action would be nullified. A 3-position switch on the front panel provides the choice of beat-frequency or "heterotone" oscillators, or none.

While each channel has its own agc system, the two are so inter-connected that both channels are jointly controlled. Thus at an instant when the signal is strong in one antenna but weak in the other the agc system in the corresponding channel takes control of both. In this way the noise, which would otherwise rise to a high level in the channel in which the signal is weak, is automatically throttled down and the average signal-to-noise ratio much improved.



Above: Overall and audio fidelity curves.

Below: Top view of receiver showing location of parts.



Noise limiter circuits are included in each channel. These are entirely automatic in their action and do not alter the audible received signal in any way.

The question of suitable antennas is important to any consideration of diversity reception. This type of reception provides maximum reduction of fading when the antennas are very widely separated or are separated a distance related to the wavelength of the received signal. The latter scheme is out of the question where the receiver is to be called upon to cover a range of frequencies; also the wide separation of antennas is impractical at most receiver locations. Moreover, it has been clearly demonstrated experimentally that an excellent degree of diversity reception is obtainable even with the two antennas mounted within the narrow confines of an ordinary housetop, provided they are in different planes of polarization. Any type of antenna which with an ordinary receiver, would be suitable for reception of the desired signals will likewise be suitable for use with this diversity receiver. These may be of the "L" type or doublets, provision being made for both of these types in the input terminal arrangement of each channel. The only specific limitations are that the down-leads be kept at least ten feet apart and that the angle formed by the two antennas, whether in the same or different planes, be not less than ninety degrees.

In very confined quarters, a vertical antenna working against one that is horizontal will prove effective. These need not be the same length, as their

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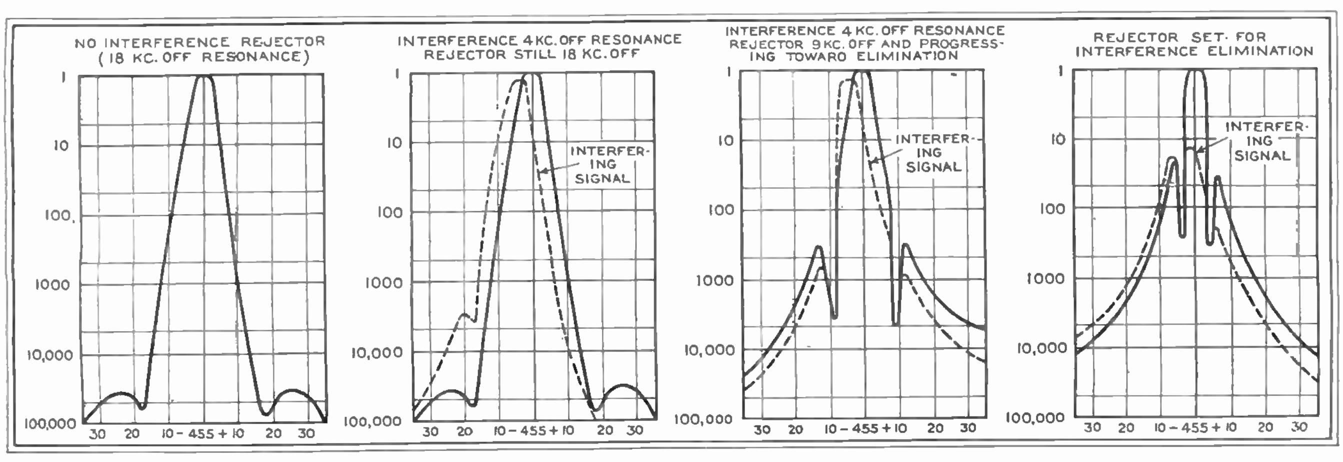
Curves showing the effect of the "rejector."



THE WQXR RECEIVER

By R. LORENZEN

OF THE THREE broadcasting stations in the United States which are licensed to operate with a carrier frequency having a band width of 20 kilocycles, WQXR is the only one which covers the area of greater New York. Coupled with the fact that such a band width permits the faithful transmission of frequencies up to 10,000 cycles, the programs emanating from WQXR are mainly devoted to the rendition of classical music.

The WQXR 11 tube receiver, which was designed by WQXR's engineering staff under the direction of John V. L. Hogan and R. M. Wilmotte, is being manufactured by the Ansley Radio Corporation. Since the ultimate in high fidelity is possible only at such great cost as to make such a set prohibitive in price to the consumer, it was necessary to effect a compromise between these two factors. The price of the receiver was kept down by eliminating the useless gadgets usually found in commercial radio receivers. The keynote, "Fidelity at a reasonable price," has resulted in a receiver which should materially enhance the auditor's pleasure in both radio programs and the reproduction of phonograph records.

Since, at least for the present, only one type of receiver is to be sold, it was considered essential that the set be usable in the entire metropolitan area. This necessitated the manufacture of a so-called universal radio, that is, one which could be used on either alternating current or direct current, as desired.

In designing this receiver, the flatness of frequency response was considered carefully but more emphasis was placed on the minimization of harmonic distortion and self-reverberation. Harmonic distortion not only arises in tube circuits but also occurs by virtue of the construction of the loud-speaker and the manner in which the speaker is housed. Unless the receiver is considered in relation to the speaker to be used with it, harmonic distortion will result in the production of frequencies which did not exist in the original sound. Self-reverberation is due to a lack of dumping in either the electrical or mechanical circuits, and results in a boominess of the reproduced music particularly at low frequencies.

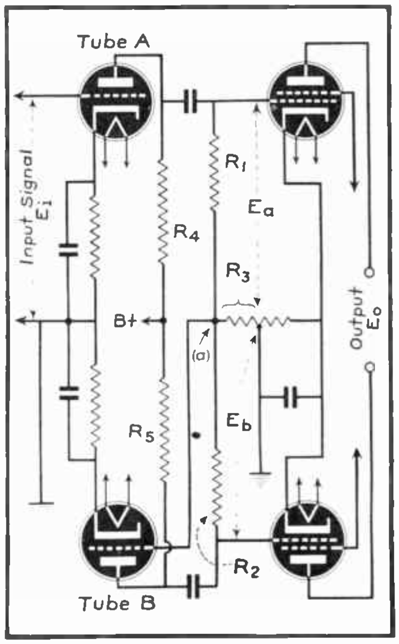


Fig. 3. The phase inversion circuit used in the receiver.

The WQXR receiver will receive stations in the broadcast band only (from 540 to 1800 kilocycles). There are no short wave bands.

TUNER

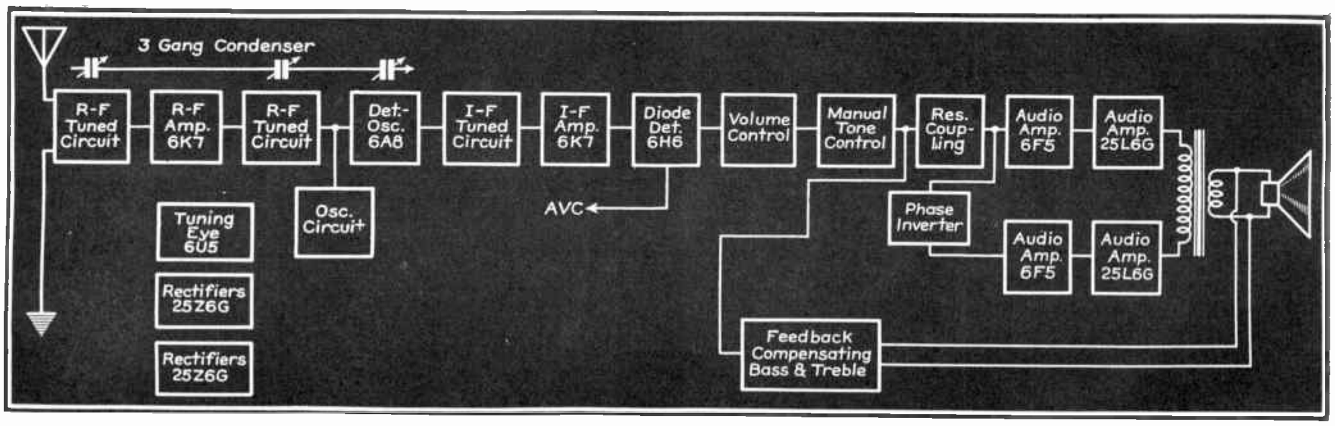
As can be seen from Fig. 1, the radio tuner is comprised of a combination of a straight radio-frequency amplifier and a superheterodyne. One stage of radio frequency employing two tuned circuits is fed to a detector-mixer, this output undergoing one stage of intermediate-frequency amplification, and then being rectified at a high level with a diode detector.

A stage of straight radio-frequency amplification precedes the superhet portion as this results in a substantial reduction not only in the inherently high noise level of a superheterodyne but also in cross modulation.

A variable selectivity switch is provided so that broad band tuning is accomplished when high fidelity radio reception is desired. This is done by overcoupling the i-f coils so that the familiar double-hump curve is obtained. If interference from another station should occur the selectivity switch can be thrown to reduce the coupling, the resulting single-hump curve then giving greater selectivity. The curves shown in Fig. 2 represent the two conditions. The double-hump is not apparent as it is merged with the single-hump curve from the r-f stage.

Automatic volume control is obtained

Fig. 1. Block diagram of the WQXR receiver.



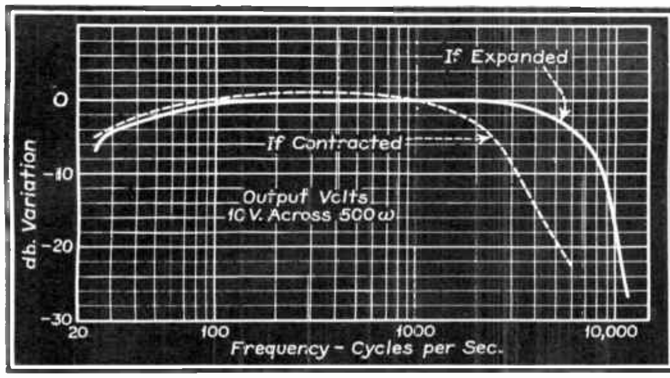


Fig. 2. Selectivity curves.

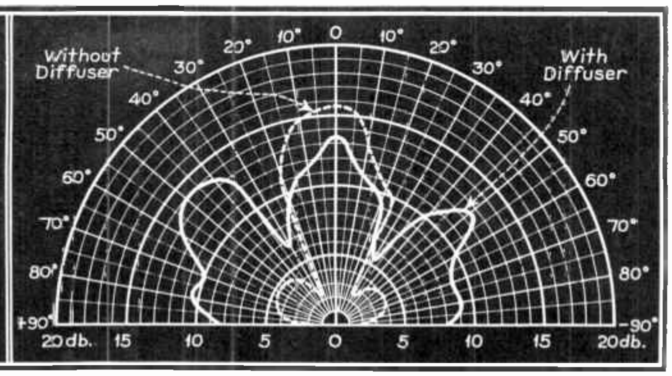


Fig. 5. Showing effect of speaker diffuser.

from diode load circuit in usual manner.

The audio channel is comprised of four tubes, two 6F5's in a self-balancing phase inversion circuit, feeding the two 25L6G output tubes operated as a Class AB push-pull amplifier.

Previous systems of phase inversion suffered from two principle defects. The variations in the characteristics of phase inverting tubes of the same type was sufficiently great, so that if a phase inversion tube had to be replaced, the amplitudes of the voltages impressed upon the two push-pull grids would be different. A similar difference in voltage amplitude resulted whenever a variation occurred in the resistance from which the voltage to be inverted was obtained.

The self-balancing phase inversion circuit used in the WQXR receiver is shown in Fig. 3. This circuit overcomes the two disadvantages mentioned, and since the circuit is degenerative, the stability that is characteristic of degenerative amplifiers is obtained. For further details reference should be made to RCA Application Note No. 97.

The undistorted power output is conservatively estimated at 3 watts. Two additional tubes may be inserted in output stage in order to obtain total of 6 watts output. This will necessitate a different output transformer to match new load, requiring 2 additional rectifier tubes.

The inclusion of a tone control between detector and audio amplifier was in part a concession to public taste. It is unfortunately true, as has been demonstrated by author on numerous occasions, that when a person who has been accustomed to listening to the usual commercial radio is asked to listen to a high fidelity receiver his reaction will be one of dislike. The brilliance of the high frequencies makes him feel that the tone lacks "mellowness." The inclusion of a tone control on a radio so that the few high frequencies which did come through could still further be eliminated has resulted in a degeneration of the average listener's auditory response. He will find, however, that with a set fundamentally free of distortion, he will want to hear the high notes. The tone control may also be used to reduce scratch on poor records.

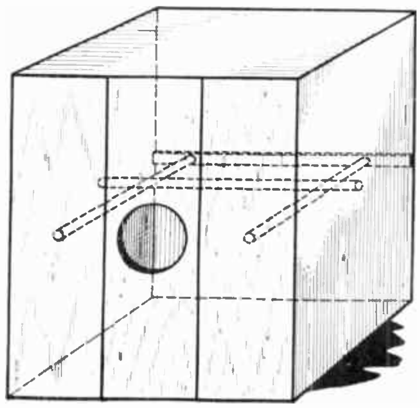


Fig. 4. Cross bracing is used to dampen reverberation.

The feedback circuit is comprised of resistors and condensers and is designed to afford less feedback at the low and high frequencies. Since the feedback is degenerative, by being less at the low and high frequencies, the output response curve from radio input to antenna to sound output of speaker is substantially flat and is about 6 db from 50 to 8000 cycles at the output of the speaker. The feedback also reduces the harmonic distortion to a negligible amount.

The 12-inch electrodynamic speaker is housed as high as possible in cabinet. The cabinet is open at back and is so proportioned and braced as to improve loudspeaker response and minimize the cabinet resonance at its natural frequency. To further dampen reverberation the cabinet is cross-braced as shown in Fig. 4. One brace joins the centers of the two side walls. Assuming that the front of the cabinet is divided into three vertical sections with

(*Continued on page 32*)

John V. L. Hogan, radio engineer and president of WQXR, examining the first model of WQXR's receiver.

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"A Record-Saving Pickup" — R. P. Glover—*Electronics*, 1937, February, pp. 31-32: Mechanical design of pickup so oriented that tracking error is minimized.

"Performance of a Direct Lateral Recording System" — F. W. Stellwagen — *Communication and Broadcast Engineering*, 1937, July, pp. 12-14, 27: Layout of a typical recording system. Test layout for checking frequency response of system. Typical response and distortion curves.

"Advanced Disc Recording"—C. J. Le Bel — *Electronics*, 1938, November, pp. 34-36, 82: Modernization of recording equipment. Extension of frequency range. Minimization of distortion. Control of surface noise or scratch.

"A Turntable Wobble Indicator"—W. F. Wichart — *Electronics*, 1938, February, p. 13: Stroboscopic method for determining wows or fluctuation in speed of rotation of the turntable.

"Gramophone Tracking"—F. Record—*Journal of Scientific Instruments*, 1932, September, pp. 286-289: Geometrical study of tracking. Setting for least tracking error.

"Instantaneous Recording Needles"—R. H. Ranger—*Communications*, 1937, December, pp. 16-17: Characteristics of needle. Action of stylus. Effect of needle on surface noise and cross-modulation.

"Measurement of Speed Fluctuations in Sound Recording and Reproducing"—A. R. Morgan and E. W. Kellogg — *Journal*

(Continued on page 27)

OVER THE TAPE . . .

NEWS OF THE COMMUNICATIONS FIELD

BEVERAGE RECEIVES ARMSTRONG MEDAL

In recognition of his pioneer work on wave antennae and his continued work in this and other phases of the radio art, the award of the Armstrong Medal by the Radio Club of America was made to Harold Henry Beverage.

Almost from boyhood he has been actively interested in all phases of radio, his first amateur station having been built in 1910. As a radio engineer and under the tutelage of Alexanderson, he rapidly made a name for himself in the development of radio transmission.

To both the amateur and professional worker his name has been immortalized in the Beverage antenna, the precursor of wave antennae of all types. His later work in the development of spaced diversity antenna systems is of outstanding importance in present day radio communication.

SOUND AMPLIFIER GUIDE

Just released by Thordarson Electric Mfg. Co., 500 W. Huron, Chicago, Illinois, this guide presents practical and theoretical information on amplifiers ranging from 8 to 120 watts output. Features of this guide are a phone-radio amplifier with volume expansion and flexible tone controls, and a combination 6 volt—115 volt portable amplifier capable of delivering high undistorted output. The Sound Amplifier Guide No. 346-D may be obtained from any Thordarson distributor or will be sent postpaid from the factory for 15c. It is also included in the Sound Section of the No. 340 Transformer Manual, listing at 50c postpaid.

SUPREME CHIEF ENGINEER

The Supreme Instruments Corporation recently announced the promotion of E. G. Perkins to the position of Chief Engineer. "Perk," as he is known to his many friends, has advanced steadily during his stay with Supreme.

PYRAMID METALS PLANT

Pyramid Metals Company have moved their factory and office from 455 N. Oakley Blvd., to 1335 N. Wells Street, Chicago, Illinois. The new plant offers increased production space for the manufacture of metal mouldings. Officers are Ira L. Reed, President, and Christopher Tonney, Sales Manager.

GRAF OPTICAL APPOINTMENT

George Silverstone, long identified with the radio and printing business, has been appointed General Sales Manager of the R. Graf Optical Company, 711 West Lake Street, Chicago. William Hoffman & Associates have been appointed to serve as advertising counsel for this account. Graf are manufacturers of lenses for use in photographic light projection and scientific instruments.

WESTERN ELECTRIC APPOINTMENT

Frederick R. Lack, formerly director of vacuum tube development at Bell Telephone Laboratories, was appointed General Commercial Engineer of the Western Electric Company. He will have charge of the sale, through the Company's distributors, of Western Electric products outside of the Bell System, including the by-products of telephone research such as broadcasting equipment; aviation, police and marine radio; public-address systems; hearing aids; train-dispatching systems, etc.

RECTIFIER MANUAL

The new B-L Rectifier Manual contains information on rectifier construction, application and performance. Rectifiers and filter circuits are discussed, and typical ratings shown. New developments include heavy-duty single-stack rectifiers and forced-draft-cooled units for numerous applications. Copies of the booklet are available to engineers, purchasing agents, and others addressing The B-L Electric Manufacturing Company, St. Louis, Missouri, on their company letterhead.

JAMES J. WELCH DIES

James J. Welch, Vice President in charge of the Traffic Department of the Western Union Telegraph Company, died after an illness of two weeks, at Nassau Hospital, Mineola, L. I. He was sixty-seven years old. Mr. Welch had been with the telegraph company for forty-eight years, starting as a telegraph operator at Davenport, Iowa. He became the head of the Traffic Department of Western Union fourteen years ago.

GENERAL ELECTRIC APPOINTMENTS

Robert A. Jones, engineer at General Electric's Buffalo office, has been appointed assistant engineer for the company in the New York district, it is announced by H. H. Barnes, Jr., commercial vice president. W. C. Plumer of the G-E Newark Office, goes to Buffalo as engineer, and L. F. Stone becomes engineer at the Newark office of the company. The three appointments were effective December 1.

CORNELL-DUBILIER, INTL. STANDARD ELEC. AGREEMENT

Announcement has been made by Mr. Octave Blake, Jr., President of Cornell-Dubilier Electric Corporation, and Mr. H. M. Pease, Vice-President of International Standard Electric Corporation, 67 Broad Street, New York, of an agreement reached between their respective companies. Under the terms of the contract, the assistance of the engineering, manufacturing and commercial divisions of Cornell-Dubilier for the production and sale of electric capacitors becomes available to the International Standard Electric through its affiliated manufacturing companies abroad.

OXFORD TECHNI-TALKS

A publication titled "Oxford Techni-Talks" will be released periodically by Oxford Tartak Radio Corporation. These semi-technical bulletins containing practical and helpful information, deal with the application and installation of public address and replacement speakers.

The first issue is scheduled for early release; jobbers, public address engineers, and servicemen who would like to receive these bulletins may secure them by sending their request to Oxford Tartak Radio Corporation, 915 W. Van Buren St., Chicago, Illinois.

FERRIS BULLETIN

The Model 32 Radio Noise and Field Strength Meter is the subject of a bulletin recently released by the Ferris Instrument Corporation, Boonton, N. J. Complete details are given. To secure a copy of this bulletin write to the above organization.

SOLAR CHIEF ENGINEER

Solar Mfg. Corp., of New York City and Bayonne, N. J., announces the advancement of Mr. J. I. Cornell to fill the position of Chief Engineer recently vacated by the resignation of Mr. N. Schnoll. Mr. Cornell came to Solar as Consulting and Field Engineer early this year, having previously been Chief Engineer and Director of the Magnovox Company. Prior to that he had been with RCA as section engineer on components, and with General Electric Company.

GRAHAM TO I.R.E. BOARD

Virgil M. Graham, tube application chief for the Hygrade Sylvania Corporation, was re-elected to serve a second term on the board of directors of the Institute of Radio Engineers at a meeting held in New York recently. He was elected to serve his first term in 1935. Mr. Graham has been in the organization for the past fifteen years, having become associate member in 1924. In 1927 he became a full member and in 1935, a fellow.

McMURDO SILVER JOINS GUTHMAN

It has been announced that McMurdo Silver has joined Edwin I. Guthman & Co., Inc., to re-engage in the kit and parts field. His latest is said to be a "Diversity Coupler" which turns any set into a dual-diversity receiver.

INSULATION GUIDE BOOK

A guide book on electrical insulating materials has recently been published by the Mitchell-Rand Insulation Co., 51 Murray Street, New York City. A great deal of useful and interesting material is contained in this 38-page booklet, a copy of which may be secured from the above organization.

RCA BULLETINS

Three interesting bulletins have recently been made available by the Aviation Radio Section, RCA Manufacturing Co., Inc., Camden, N. J. Data Sheet No. 1 covers the Model AVA-10 crystal holders and crystal units, while Data Sheet No. 2 deals with the AVA-11 series of crystal holders and units. A description of the Model AVA 36 aircraft transmitter test kit is contained in the third data sheet. To secure these bulletins write to the above organization.

FILTERETTE CATALOG

New products for radio noise elimination, with designs based on original research by Tobe Interference Engineers, are described in the latest Tobe Filterette Catalog just off the press. Among the newly developed items are an improved unit for quelling radio noise from electric shavers, a compact Filterette to stop oil burner ignition interference, a group of new utility type capacitive Filterettes in steel outlet boxes, and the Filterette Selector. Dealers and servicemen will find in this catalog many helpful suggestions for handling radio interference problems. Write to Tobe Deutschmann Corporation, Canton, Massachusetts.

WQXR EXPANDS STUDIOS

As part of its 1938-39 expansion program, station WQXR, New York, has increased its office and studio space at 730 Fifth Avenue by almost fifty percent.

The major part of the increased space will be occupied by the station's sales department, which, effective December 1st, is under the direction of Robert M. Scholle as Sales Manager. Norman S. McGee, formerly Sales Manager, has been advanced to Director of Agency Relations.

FINCH PATENT

W. G. H. Finch, president of the Finch Telecommunications Laboratories, Inc., announced today that William A. Bruno of N. Y. City has taken out a license under the Finch Facsimile Patents and will manufacture Finch facsimile receivers in "Kit" form.

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ELECTRIC RESONANCE CHAMBERS

(*Continued from page 8*)

variety of materials at 2930 mc for $A = 2''$ and $D = 1''$. Further tests indicate the function of water is mostly reflection and not absorption.

When B is adjusted to be near a free space wavelength two positions for L can be found in the chamber roughly a quarter wavelength from each end. By inserting two dipoles with proper coupling the factor Δ and resultant performance of the chamber as a sink of wave power can be increased. Similarly if the chamber is operated in one of the higher modes of resonance additional dipoles may be inserted for lower modes and by properly coupling together the factor Δ may be increased.

The exact relationships between Δ, Q, A and tuning of L merits further investigation.

[1] "Hyper Frequency Wave Guides" by G. C. Southworth, page 284, April, 1936, *Bell System Technical Journal*.

[2] "Transmission of Electromagnetic Waves in Hollow Tubes," by W. L. Barrow, page 1298, October, 1936, *Proc. IRE*.

VETERAN WIRELESS OPERATORS ASSOCIATION NEWS

W. J. McGONIGLE, President — RCA Building, 30 Rockefeller Plaza, New York, N. Y. — H. H. PARKER, Secretary

GREETINGS

TO OUR MEMBERS, friends and well-wishers we extend on behalf of our officers and directors our best wishes for a Merry Christmas and a happy and prosperous New Year. Our grateful appreciation to all who cooperated during the past year in making it one of our most successful. We look forward with pleasure to a continuation of this cooperative spirit during the coming year.

JANUARY MEETING

THE ANNUAL MEETING of the Veteran Wireless Operators Association will be held at the Hotel Astor, Times Square, New York City, at 7 PM on Monday, January 9, 1939. The ballots which have been mailed the membership will be opened and counted by a tellers committee appointed by the President from among the members present. The officers and directors elected will be announced and will assume office immediately. We earnestly request your attendance at this meeting as it is the last meeting before our Annual Cruise and final plans for the "Big" affair will be discussed.

NOMINATIONS

THE NAMES of those nominated by the Board of Directors at a meeting held in New York City on Tuesday evening, November 22, 1938, for officers and directors follow: President, William J. McGonigle; Vice-President, A. J. Costigan, Paul K. Trautwein, A. F. Wallis; Secretary, H. H. Parker; Treasurer, C. A. Carney, H. T. Hayden, Wm. C. Simon; For Director of which eight will be elected: Harvey Butt, George H. Clark, A. J. Costigan, W. S. Fitzpatrick, R. H. Frey, C. D. Guthrie, A. A. Isbell, William J. McGonigle, Fred Muller, E. A. Nicholas, Frank Orth, H. H. Parker, O. W. Penny, Carl O. Peterson, J. R. Poppele, W. C. Simon, Paul K. Trautwein, Arthur F. Van Dyck, A. F. Wallis, H. P. Westman.

DINNER-CRUISE

THE FOURTEENTH Annual Dinner-Cruise of the Veteran Wireless Operators Association will be held at the Hotel Astor, Times Square, New York City, on Saturday evening, February 11th, 1939. Simultaneously our chapters will hold dinner-cruises to be participated in by their local members and friends. Each year we add several new chapters joining in this annual get-together which serves as a stimulus for the further progress of our association and makes possible the renewing of acquaintances made in the early days of radio.

The Dinner-Cruise at the Astor Hotel will include a full-course dinner and a cocktail to each person. There will be dancing from ten to three to the scintillating rhythms of Lou Lang and his splendid orchestra. A short sketch will be presented by the VWOA DRAMArians; this should prove interesting—you will know all the characters.

A prominent feature of the evening will be the annual awards for meritorious service and it is likely a coast-to-coast broadcast will accompany the presentations.

Tickets will be $4.00—payable in advance. In past years our experience has been that only a small proportion of those attending paid for their tickets in advance. It was therefore very difficult to predict the actual attendance. Because of this considerable losses have been incurred due to our having provided facilities for many who had promised to attend but failed to do so. Guarantee requirements have become more rigid and the present practice is that not more than ten per cent in addition to those guaranteed will be set up. This means that unless we know precisely how many will be there an attendance prediction based on previous years must be made with some allowance for overflow. As has happened sometimes an overflow considerably in excess of that predicted attended, making necessary a hurried setting up of tables to accommodate them and consequent inconvenience to those already seated. To eliminate these hazards we must in all fairness to ourselves and those who have made it a practice to purchase their tickets in advance insist that tickets must be purchased in advance of the Dinner-Cruise. If this practice is followed it will increase the enjoyment of those attending and will facilitate the work of the committees in providing adequate features for the affair. Will you, therefore, please advise us at the earliest possible moment as to your ticket requirements. The earlier you send in your money for tickets the greater will be the success of the Cruise. Should you have paid for tickets and at the last minute conditions arise which make impossible your attendance at the Dinner consideration will be given your request for a refund. We want you to buy your tickets early—and be there! The price of tickets is set so that with normal attendance expenses will be met. We look forward to greeting you at the Hotel Astor, Saturday Evening, February 11th, 1939. Please be there.

VITAL STATISTICS

TO MR. AND MRS. R. H. Pheysey a baby girl, Gail, on October 28, 1938. To Mr. and Mrs. William J. McGonigle a baby boy, John Hugh (the chief reason why there was no VWOA News page in the November issue) on October 18, 1938.

BOSTON

AT THE NOVEMBER MEETING of the Boston group, Raymond F. Trop, former Treasurer was elected Chairman; Guy R. Entwistle was elected Vice-Chairman and Bart McCarthy was elected Secretary-Treasurer. Our cordial greetings to the new officers and best wishes for a successful tenure of office.

PERSONALS

PETER PODELL one of our Charter members now has his own automobile agency in the Bronx. Look him up in case you are in the market. . . . A. I. Yuter writes and sends in the necessary. Hope to see you at the Astor on the 11th AIY. . . . Sorry to hear of the recent accident in which Carl Peterson broke several toes. Hope you will be back in the running very soon Carl. . . . Joseph Hopfenberg at the December meeting reminiscing with another real oldtimer Fred Klingenschmitt. . . . Our sincere thanks to Ray D. Rettenmeyer, Editor of COMMUNICATIONS, for his splendid cooperation during the past year. . . . Remember—the secretary will appreciate your sending in your dues—for 1938 if you owe them, for 1939 if paid up for 1938. Your support will aid materially in lessening the burden on the secretary. Thank you. . . . We welcome and introduce to the membership new member Archibald MacIntyre, ex-Chief Radioman of the old navy in the days of Iron Men. Mr. MacIntyre's service included duty on the *U.S.S. Pennsylvania, U.S.S. Lydonia, U.S.S. Despatch* and still follows in the radio field. Mac is also Commander of the Veterans of Foreign Wars, Department of Florida. We are looking toward a large and active Chapter in the Tampa district. . . . Secretary McCarthy of the Boston Chapter has advised that a committee meeting for the nomination of officers will be held at the Hotel Manger, Boston, Mass., on November twelfth at 6.30 P.M. . . . Mr. Geo. P. Smith, Jr., has forwarded his dues up to and including 1940. Members everywhere does your conscience bother you? The Secretary will be glad to send 1938 cards to those needing them. . . . Also—we urge all Chapters and members to forward news of their activities for publication. How about it Honolulu, San Francisco, Chicago, Boston, Miami, etc., etc., etc. . . . New Members—an old timer Henry F. Wiehr became member VWOA Nov. 2, 1938. Started Commercial Operating in 1914 with Marconi Co. Saw service on approximately 25 ships. Mentioned in Baarslag's "SOS to the Rescue" in connection with the Admiral Sampson disaster. Still pounding brass and is now operating on the *SS. West Planter* out of Frisco. . . . George N. Mathers formerly U. S. Army R.M.C.A. Dollar line Round the World and now T.R.T. Co. . . . Merrill G. Dobbs of New Orleans and recipient of our Testimonial Award, 1938. . . . W. G. Stedman of Flushing, N. Y. Formerly U.S.N., *U.S.S. Paducah, U.S.S. Mayflower*, Swan Island and New Orleans, for the T.R.T. . . . Associate J. T. Bensley, formerly Bull S.S. Line, now a junior at the University of Michigan.

RECORDING BIBLIOGRAPHY

(Continued from page 22)

Acoustical Society America, 1936, April, pp. 277-280: Design of a "wow-meter" to test fluctuations in turntable speed. The current generated by a special toothed steel wheel is fed to an electric circuit so designed that frequency variations cause deflection in a galvanometer.

"Shellac vs. Synthetic Resin in Phonograph Records" — J. P. Dunne — *Plastic Products,* 1934, March, pp. 90-92: Properties of shellac and synthetic resin (resorcinol base) records. Manufacturing details.

"Recording Waxes" — V. Williams — *Industrial Chemist,* 1935, October, pp. 400-401: Physical Properties. Recording waxes are mixtures of lead and sodium soap in stearine and montan wax. Analysis shows presence of about 4.5 to 9.5 percent lead oxide.

"New Synthetic Resins in Manufacture of Gramophone Records"—E. P. Irany—*Canadian Chem. and Met.,* 1936, June, pp. 193-195: Body and record requirements. Description of polyvinyl resins.

"Unbreakable Gramophone Records"—H. C. Bryson—*Chem. Age,* 1932, Dec. 10, pp. 546-547: Brief description of natural resins, synthetic resins, and cellulose derivatives.

"High Fidelity Lateral Cut Disc Records"—F. C. Barton—*Journal Soc. Mot. Pict. Eng.,* 1934, March, pp. 179-182: Address and discussion of recording on synthetic resin records, surface noise, volume range, cutting and reproducing methods. Records directed for home use.

"La Fabrication des Disques de Phonographe"—G. Worms—*Genie Civil,* 1934, March 17, pp. 243-247: Data on manufacture and stamping of records. Types of compounds used.

"Manufacture of Phonograph Records"—R. A. Dimon—*Metal Industry* (N. Y.), 1932, March, pp. 105-107: Description of the electroplating process in the manufacture of non-metallic records.

"Gramophone Record Matrices"—E. A. Ollard—*Metal Industry* (London), 1936, Aug. 14, pp. 165-169; Sept. 4, pp. 239-242; Sept. 11, pp. 265-266: Complete treatment of production manufacture of matrices by electroplating.

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"Disc Recording" — T. L. Dowey — *Communications,* 1937, November, pp. 24-32: Steps in the production of the master and pressings. Wax flowing, gold sputtering, pre-plating, copper-forming, master finishing, cleaning and chromium-plating, pressing.

"Electric Gramophone"—S. F. Philpott—*Electric Review* (London), 1932, July 8, pp. 46-47: Mounting systems. Methods of driving and governing.

"Einphasen Induktion Smotern Fuer Schalliplattenantriebe" — *Elektrotechnische Zeitung,* 1935, November 14, pp. 1254-1256: Design data for 1Φ, 50 cps, 78 rpm motors. Comparison of European motors.

"Einphasen Synchronmotor Saja Fuer Sprechmaschinenantrieb" — K. Kaufman — *Elektrotechinsche Zeitung,* 1934, March 1, pp. 213-214: Data on Saja 1Φ, 50 cps, 78 rpm, motor. Torque is 6.6 cm-Kg.

"The Induction Disc Phonograph Motor"—C. I. Hall—*General Electric Review,* 1921, pp. 218-221: Description of motor. Operating characteristics.

"A Reproducing Machine for Picture and Sound" — H. Pfannenstiehl — *Transactions Society Motion Picture Engineers,* 1929, No. 38, pp. 253- 261: W-E record reproducing unit. Motor drive. Filter. Gear system.

"Synchronization and Speed Control of Synchronized Sound Pictures" — H. M. Stoller—*Transactions Society Motion Picture Engineers,* 1928, No. 35, pp. 696-708: Description of speed regulation systems. AC and DC speed control methods.

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R-F OSCILLATOR

(Continued from page 13)

rent through the microammeter will never be greater than about 1.2 times the full-scale value.

Another useful feature of the vacuum-tube voltmeter is the provision of means for measuring percentage modulation. When the switch marked "Modulation %" is open, the effective capacity in the rectifier system is 0.001 mfd. The result is that, even when the meter is on the low-sensitivity range, the time constant is so small that the meter reads carrier peak voltage independent of the degree of modulation. When the modulation percent switch is closed, the effective capacity is of the order of 0.3 mfd, and when the low-sensitivity range is employed the time constant is so large that the condenser charges up to the maximum impressed voltage, and hence reads E(1+M), E being the carrier amplitude.

In order to determine the percentage modulation, the voltmeter is used on the low-sensitivity range and the output voltage turned up, disconnecting the load if necessary. The two readings just described are then taken, and from the resulting data M may be readily calculated. Changes in the position of the output tap switch or of the load impedance will have very little effect upon the percentage of modulation.

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PLATE DISSIPATION LIMIT

(Continued from page 11)

ten in the assumption that the wall thickness is small as compared to the anode diameter, and that there is no essential temperature drop across the anode wall. This is, of course, not quite so with the heavy wall anodes, especially with those made of poorly conducting material. Nevertheless, the derived expression in all cases disclose correctly what factors are responsible for non-uniformity of the temperature distribution in the presence of the grid focusing effect and what is the trend of their individual effects. The outlined method is, of course, applicable not only to the case of water-cooled tubes, but also to the tubes cooled by air blast and to those cooled by radiation.

TELEVISION STANDARDS

(*Continued from page 16*)

Thus in June, 1936, the first part of the job had been completed. We realized other necessary standards had to be recommended. However, it is not well to standardize too early. Research continues. Many experiments were being carried on daily in various television laboratories, yielding new results, new methods. Also, the successes and difficulties experienced in England, where daily television programs were being received in several thousand homes, served as guide posts to us. Germany was also making rapid progress in television. Foreign developments were carefully watched. Several groups of engineers from our Subcommittee visited foreign television stations. They returned with ideas about standards, both new and old. For instance, the Committee reopened the question of positive and negative transmission. To aid in a decision special tests were arranged at RCA and at Philco, to show comparative receiver performance under conditions of various amounts of electrical disturbance with positive and negative transmission. The decision was for negative transmission, influenced principally by the easier automatic-gain-control design.

Additional standards were added as the months passed until there remained only one highly important feature undecided, the vertical synchronizing signal. In May, 1938, pressure was placed on our Committee to settle this point so that recommended standards, sufficiently complete for transmitter and receiver development, would be available without delay. Two different types of synchronizing pulses had been in use in field tests for several years, namely, the "serrated vertical" and the "narrow vertical" pulse. One company recommended one, another company the other. By a majority vote a modified form of "serrated vertical" was adopted. It permits latitude in choice of receiver synchronizing circuits.

This was the last important standard to be recommended for the present, so the Sub-committee, feeling that their undertaking, for the time being, had been satisfactorily completed, forwarded the set of standards, printed here, to the main Committee. They were speedily approved by the various groups, as outlined above. They are now being formally presented to the Federal Communications Commission.

It is realized that additions and changes may be required as the art progresses. The standards, together with the "Comments," are given in accompanying tables.

The Sub-committee also has acted as spokesman for the industry regarding frequency assignments for television. The present experimental assignments are given in Fig. 3.

As commercial television approaches, RMA Television Committee activities increase. Recently the following subcommittees have been appointed:

Television Interference, under the leadership of J. E. Brown of the Zenith Company. The first meeting has been held and plans for an important demonstration of the effects of automotive interference on television pictures are being arranged.

Television Transmitters, E. W. Engstrom, RCA, Chairman.

Television Receivers, I. J. Kaar, General Electric Co., Chairman. Good progress was made in the first meeting held in September.

A large majority of the leading interests that compose the radio industry today intend to enter the television field tomorrow. Many of them have expressed the belief that with the adoption of television transmission standards by the FCC a serious barrier to successful commercial television will be removed. Thus, we in the U. S. will be brought nearer the realization and enjoyment of that long-awaited service, *Television.*

APPENDIX

Comments on Standard T-111, *RMA Television Signal.*

(*Continued on page 33*)

REPORT OF ROCHESTER FALL MEETING

THE 1938 Rochester Fall Meeting of the Institute of Radio Engineers and the Engineering Division of the Radio Manufacturers Association was held at the Sagamore Hotel, Rochester, New York, on November 14, 15 and 16. It was a large and successful gathering, the total registration being in the vicinity of 500.

It is especially significant to note that out of sixteen papers delivered at the technical meeting, about six were devoted to television. These included papers by P. T. Farnsworth, Farnsworth Television, Inc., on "Image Amplifier Pickup Tubes;" I. G. Maloff, RCA Manufacturing Co., on "Gamma and Range in Television;" S. Goldman, General Electric Co., on "Television Detail and Selective Sideband Transmission;" Foster and Seeley, RCA License Laboratory, on "Principles and Methods in Television Laboratory Technique;" B. C. Gardner and C. Larson, Farnsworth Television, Inc., on "Production of Image Dissector Tubes for Motion Picture Pickup;" and H. T. Lyman, General Electric Co., on "Television R-F Input Circuits." In addition W. R. G. Baker, General Electric Co., gave an unscheduled talk on the economic and business phases of television, pointing out the engineers' place in the new field.

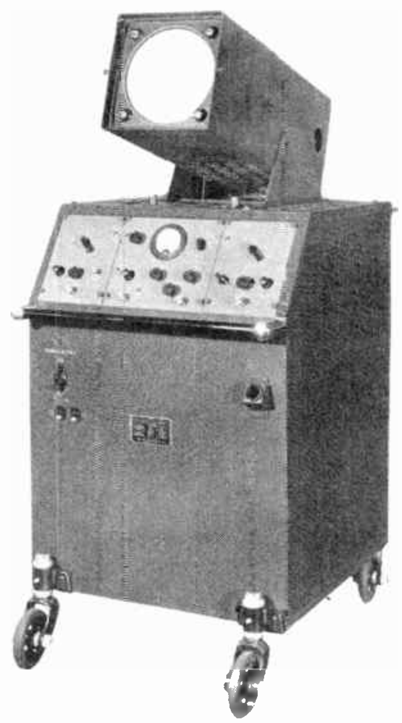
Among the interesting papers was that of Hugh Knowles, Jensen Radio Mfg. Co., on "Loudspeaker Consideration in Feedback Amplifiers." Mr. Knowles analyzed the problem and dealt with the application of feedback to loudspeakers.

The paper on "Frequency Modulation" by C. B. Fisher, Northern Electric Co., was also well received. While Mr. Fisher's paper was in the nature of a summary on the work that had been done on frequency modulation during the past few years, it contained a good deal of valuable information.

Special mention should also be made of the paper by Harold A. Wheeler, Hazeltine Service Corp., on "The Interpretation of Amplitude and Phase Distortion in Terms of Paired Echoes," as well as to papers on "Standardized Intermediate Frequency" by J. E. Brown, Zenith Radio Corp., "The Over-Voltage Timer and an Example of its Application to the Measurement of Radio Interference" by C. M. Burrill and E. T. Dickey, RCA Manufacturing Co., "The Measurement of Radio Interference" by C. J. Franks, Ferris Instrument Corp., "New High Transconductance Ultra-High-Frequency Tube" by A. P. Kauzman, RCA Manufacturing Co.

TELEVISION TEST EQUIPMENT

RCA HAS DEVELOPED a number of pieces of television test equipment which it is making available to laboratories, experimental television stations and to the industry in general for carrying forward a program of television service. This equipment was originally developed for use in RCA's own television research program but since such equipment was



This is the RCA 136-B special Cathode Ray Oscillograph, provided with amplifiers extending over the entire video band of 30 cycles to two million cycles. With it, it is possible to examine the wave form of minute impulses and to produce a large image for photographic purposes.

useful to others for television work, it has been manufactured and offered for outside sale.

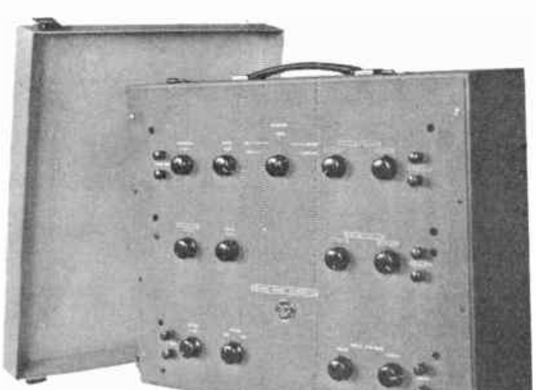
In ordinary broadcasting, for the development of sound apparatus, it is often necessary to check the frequency response over the band of 30 to 10,000 cycles. It is also desirable to check the distortion introduced in amplifiers and for this reason apparatus of this sort has been in general use. However, for television purposes, the video-frequency response of circuits extends over the range of thirty cycles to two million cycles at the minimum and because this band is two hundred times as wide as that required for present day broadcasting, very special test equipment is necessary to check the operation of apparatus.

One of the first items is a special cathode-ray oscillograph, Model 136-B, provided with amplifiers extending over the video band. Thus it is possible to examine the wave form of minute impulses and to produce a large image on the cathode-ray oscillograph tube for photographic purposes. Many cathode-ray oscillographs have been manufactured previously but few, if any, have been able to amplify over such a wide band. Oscillographs of this type have been used by RCA in the Empire State installation and by the Columbia Broadcasting System for experimental television work.

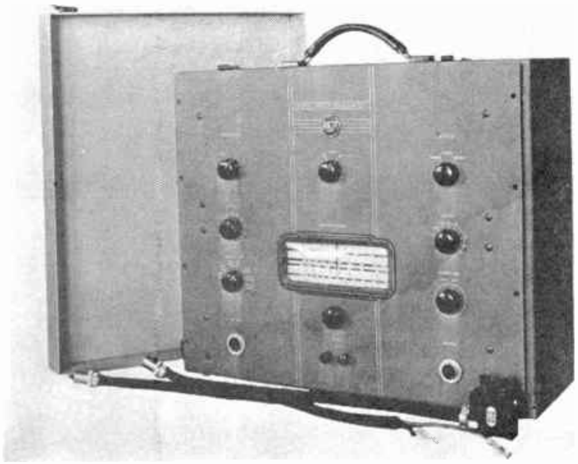
Another piece of test equipment is the video sweep oscillator which enables engineers to adjust amplifiers to provide the necessary wide band response. By the use of this equipment and the cathode-ray oscillograph, it is possible to observe the frequency-response curve of the equipment under test and to make necessary adjustments to produce the desired response. Such equipment saves many hours of time over the conventional method of using a beat-frequency oscillator and plotting out response curves point by point.

Perhaps the most unique piece of equipment is the square wave generator. Early in the program of RCA's television research, it was discovered that by transmitting a square wave through the apparatus instead of the conventional sine wave, engineers could observe the wave shape of the impulse at the output of the equipment and could tell the deficiencies in the equipment by the difference in the two forms. For example, if the amplifier being tested lacks high-frequency response, the wave would not be reproduced with square corners but would be rounded. If phase shift occurs in the amplifier, other distortions would take place which would be readily recognized. The RCA instrument produces square waves having exceedingly straight sides, at several convenient frequencies over the video band. It also possesses the property of making square waves out of sine waves which are fed into it.

RCA's new square-wave generator.



New video sweep oscillator.



RCA has also developed an ultra high frequency field intensity meter, the first to be offered commercially for checking the range of television stations and other ultra high frequency transmitters. In this way the effectiveness of antennas and the service area of the station can be determined. The instrument also is provided with an attachment for measuring the noise produced by electrical appliances throughout the ultra-high-frequency band.

Several other RCA test instruments have also been developed including an r-f signal generator, and an r-f and i-f sweep oscillator, which are of interest to television receiver manufacturers.

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TELEVISION TRANSMITTER

THE RCA MANUFACTURING COMPANY has recently announced that it will make available television transmitting equipment for sale to stations desiring to enter this field of service. This apparatus includes studio equipment, transmitters and television test equipment.

The 1 kw television transmitter is the first medium powered television transmitter to be made available by RCA. It is believed that the power of this transmitter is sufficient to enable experimental stations to render a satisfactory service over a reasonable area without too great an initial expense in starting television service. The transmitter conforms fully with the recently established RMA standards and is designed for d-c transmission with negative modulation. The video response of the transmitter extends well beyond the range required for present day 441-line pictures with equal horizontal and vertical detail, thus providing for future requirements as to frequency response. The transmitter includes many circuits specially developed to provide for good quality picture transmission.

The transmitter employs a long line controlled oscillator using an invar rod (which is unaffected by changes in temperature) to maintain the carrier frequency at a stable value. Because of the relatively high power output from the oscillator, only two buffer amplifier stages are necessary in order to drive the final power-amplifier stage. Lines are employed instead of conventional tank circuits in the radio-frequency amplifiers. A special modulator circuit is employed with the plates of the modulators directly connected to the grids of the power-amplifier tubes in order to provide for carrier control during picture transmission. Rectifier and filter circuits have been specially designed to avoid reaction and to provide an extremely low impedance at all video frequencies. The transmitter includes provision for inserting the d-c component during the picture transmission which provides for variable carrier output in accordance with the light and shade tones of the picture.

The transmitter is arranged for disassembly if necessary in transporting it into buildings since in some cases the transmitter may be located near the roof to be adjacent to the antenna system.

RCA's program of television transmitter development has been carried forward for the last five years in order to provide satisfactory apparatus at reasonable prices. It is felt that the 1 kw television transmitter will provide apparatus which may be used by television stations in the initial period of service and encourage operation on an economical basis.

The new RCA 1 kw. television transmitter. It is believed that the power of this transmitter is sufficient to enable experimental stations to render a satisfactory service over a reasonable area.

WQXR RECEIVER

(*Continued from page 21*)

the speaker in the middle one, each of the two other braces joins the center of its corresponding vertical panel with a bar at the back of the cabinet.

The method of propagation of sound waves is a function of their frequency. At low frequencies sound waves are propagated in all directions, whereas at high frequencies they travel in a beam. This beam-like characteristic is very noticeable as low as 3000 cycles. So marked is this phenomenon at high frequencies that if a loudspeaker is reproducing the sound of cymbals, which contain strong high frequency components, a very decided change of timbre will be observed as the listener moves from the front to the side of the speaker.

As it is usually neither practical nor convenient to sit directly in front of the loudspeaker, Mr. R. M. Wilmotte has devised baffle plates in front of the cone in order to diffuse the high frequencies. An examination of the curves of intensity distribution for a 6000 cycle tone, as shown in Fig. 5, for a speaker with and without such a diffuser immediately makes apparent the enormous benefits to be obtained in using this diffuser.

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DIVERSITY RECEIVER

(*Continued from page 19*)

effective pick-up will vary in any case and can be compensated in the receiver. However, it is obviously desired in any installation to make both antennas as effective as possible so that each will contribute its reasonable share to the combined results.

In conclusion it might be pointed out that no space has been given here to a discussion of the principle of diversity reception nor to the detailed advantages of such a system as compared with ordinary single channel reception. It is felt that both are too well known to require additional treatment here. The attempt has been limited to describing the features of this new receiver which make it suitable for diversity reception, or which have technical interest in instances where the designers have strayed off the beaten paths of conventionality.

Readers who are interested in discussions of principles and applications of diversity reception are referred to papers by Beverage, Peterson and Moore in the April, 1931, *I.R.E. Proceedings*; and to an article, "Recent Developments in Diversity Receiving Equipment" by J. B. Moore in the *RCA Review* for July, 1937.

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TELEVISION STANDARDS

(*Continued from page 28*)

The reader should refer to Fig. 2 and note that the "black level" divides television signal into two parts; voltages below this level represent the picture signal, those above, the synchronizing signal.

The following are the requirements of synchronizing signals:

(1) Easy separation of picture signal from synchronizing.

(2) Continuous signals for horizontal synchronization.

(3) Signals for the vertical deflecting circuits.

(4) Easy separation of horizontal and vertical signals, also vice versa.

(5) Good interlacing.

The signal shown in Fig. 2 fulfills these requirements, because:

(1) Simple amplitude selection at the receiver is sufficient with the definite "black level" to separate synchronizing from picture signals.

(2) A continuous series of sharp wave-fronts are provided throughout the synchronizing signal. These occur at the beginning of each scanning line. To permit this the vertical signal is interrupted at intervals called "serrations."

(3) A series of long pulses, marked in the drawing "vertical synch." synchronizes the vertical deflecting circuits.

(4) Due to the difference between the short-duration pulses, marked "horizontal synch." and the group of six long-duration pulses (vertical synchronizing) simple electrical circuits of several well-known types will provide separation.

(5) To take care of interlacing equalizing pulses (so marked) are provided.

Experience has indicated that the duration and relative amplitudes marked on the drawing provide good synchronization at the receiver. The other features in the diagram of the standard synchronizing signal are self-explanatory.

THE MARKET PLACE

NEW PRODUCTS FOR THE COMMUNICATIONS FIELD

U-H-F FIELD-INTENSITY METER

The RCA 301-A field intensity meter has been designed for measuring field intensities of stations operating in the high-frequency spectrum. The instrument may be used in conjunction with a standard recording meter for making records of the variation in signal intensity and may also be employed with a noise meter attachment for indicating the noise level on any particular r-f channel. The instrument covers the band of 20 to 125 megacycles over a considerable range of field intensities. It is designed to provide either linear or logarithmic output to facilitate recording.

The 301-A meter has been designed for field use and is arranged for convenient operation and for carrying from one location to another. It consists of three units—meter unit, accessory case and power supply. The power supply contains a non-spillable storage battery and a regulated vibrator system.

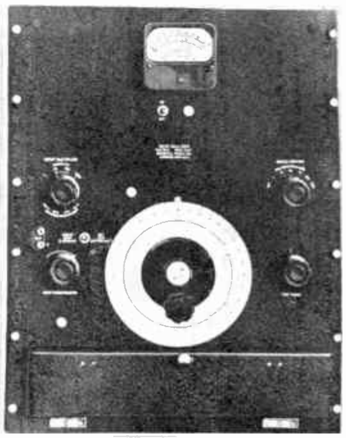
Literature is available from the Measuring Equipment Division, *RCA Manufacturing Co., Inc.*, Camden, N. J.—COMMUNICATIONS.

MU-SWITCH

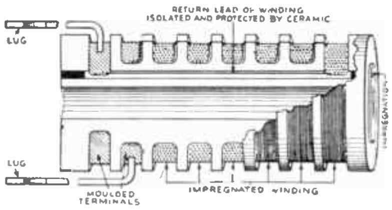
The Mu-Switch, Pat. No. 1,780,758, is a quick-acting precision switch patented November 4, 1930. The original application was filed in March 1927. Thus, the Mu-Switch is not a new development, but rather one which has years of commercial experience behind its development and manufacture. The Mu-Switch has following features: (1) Predetermined adjustment of total and deferential pressures. (2) The spring action is stamped in one piece integral and assembled with its contact member. There are no hinges or other rubbing surfaces in the switch arm assembly. (3) The switch works on the cross center, reverse action principle—first, it presses and then it snaps. This assures combined positive contact and rapid break. (4) The movement characteristics of the switch member are accurately determined before assembly. (5) Working pressures as low as four ounces can be supplied. (6) The Mu-Switch is regarded as one of the fastest mechanically operated switches ever offered the trade. (7) Adjustment is permanent, mounting of the switch in any position does not interfere with its operation.

The Mu-Switch can be supplied with various types of operating adaptors such as spring levers, spring studs, and metal cased housings. It is rated at 10 amperes, 110 volts a-c and will safely carry a non-inductive load of 1200 watts. On circuits controlling lamp loads from "off" to "on," the rating is 300 watts of lamps. Inductive loads of ½ hp can be safely handled at 110, 220, or 440 volts a-c. The d-c rating of the Mu-Switch is one ampere at 110 volts.

Mu Switch Corporation, Canton, Mass.—COMMUNICATIONS.



General Radio Wave Analyzer.



IRC Resistor

Mu Switch.

Cannon Television Connector.

WAVE ANALYZER

The new Type 736-A Wave Analyzer is a heterodyne type of instrument similar in principle of operation to its predecessor, Type 636-A, but having greater sensitivity, greater voltage range, and increased convenience of operation.

The principal feature of the new analyzer is a broad-band flat-top filter. This intermediate-frequency filter uses three quartz bars operating at 50 kilocycles. The pass band is 4 cycles wide at the top, and the response is down 15 db at 5 cycles.

The normal input impedance is one megohm. A 100,000-ohm potentiometer is provided as an alternative input system.

Complete a-c operation, linear meter scale, a high degree of stability, self-contained calibration means, high input impedance, and freedom from humidity effects are a few of the other features.

Further information may be secured from the *General Radio Company*, 30 State Street, Cambridge, Mass.—COMMUNICATIONS.

PRECISION RESISTORS

Three new types recently added to the list of IRC precision wire wound resistors, are said to employ an ingenious method for bringing both terminals out at one end. This is said to eliminate the problems of shorting and breakage at terminals frequently caused by exposed resistance wire. This is accomplished through a unique design of the base wherein the resistance wire is returned internally through the ceramic, yet completely insulated and protected from windings or mounting bolts. End leads of the resistance wire are not exposed. Complete descriptive literature may be obtained upon request to the *International Resistance Company*, 401 North Broad St., Phila., Pa.—COMMUNICATIONS.

BAKELITE RELAY COVERS

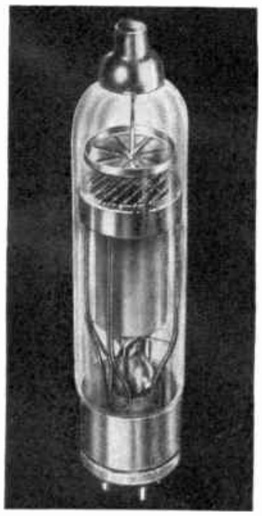
A new cover for Ward Leonard midget-type relay is now available for use where these relays with molded base are mounted on a panel. These covers are of modern design in molded bakelite and are held in place by a "snap on" fit to the base, sufficiently tight to resist accidental loosening. They provide protection against dirt and possible damage to the relay. *Ward Leonard Electric Co.*, Mount Vernon, N. Y.—COMMUNICATIONS.

TELEVISION CONNECTOR

A recent development of the Cannon Electric Development Company is the television connector shown in the accompanying illustration. It includes a 34-pole wall plug and cord receptacle. The four center contacts are for transmission line and are shielded concentrically through the plug. For further information write to *Cannon Electric Development Co., Inc.*, 420 West Avenue 33, Los Angeles, Calif.—COMMUNICATIONS.

GRID-CONTROLLED RECTIFIER

Electrons, Inc., have just announced an Xenon gas filled, grid-controlled rectifier,



type El. C6J. This tube has the following characteristics:

D-C Amps Output	
Average	6.4
Peak	77
Peak Forward Volts	750
Peak Inverse Volts	1250
Average Arc Drop Volts	9
Filament	
Volts	2.5
Amperes	18
Overall Dimensions, Inches	2 by 9

According to the manufacturer, the degree of reliability of these tubes has opened up uses in precise or high-speed control of motors and for high-speed switching circuits.

Further information may be secured from *Electrons, Inc.*, 127 Sussex Ave., Newark, N. J.—COMMUNICATIONS.

COAXIAL CABLE KITS

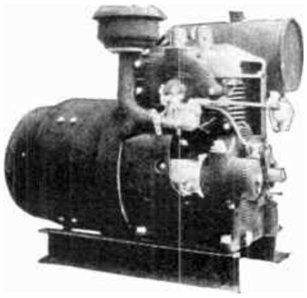
A convenient kit containing all the necessary components for the construction of ½-in. diameter coaxial cable has been made available for amateurs, experimenters and engineers. These kits include inner conductor, insulators, outer shieldings, clips, screws, nuts, eyelets and instructions for the assembly of the cable.

The trade name of the product is CO-X concentric cable. Complete details and

technical information is available from *Transducer Corp.*, 30 Rockefeller Plaza, New York City.—COMMUNICATIONS.

KATOLIGHT

A new two cylinder, air-cooled, 2000-watt a-c Katolight generates standard 110-



volt, 60-cycle a-c. It is self-excited and can be furnished with remote control or full automatic control or may be started manually. It is 28" long x 18" wide x 23" high and weighs 327 pounds. Engine has sensitive governor giving close voltage regulation. Engine has high tension magneto, completely shielded with shielded spark plugs and wires. Generator is filtered. The d-c winding has been designed to keep commutator ripple to low point. Engine is furnished with either 2½ gallon gravity tank or with fuel pump. *Kato Engineering Co.*, Mankato, Minn.—COMMUNICATIONS.

RECORDING MICROSCOPE

Universal Microphone has added a new item to its recording division in the form of an adjustable power microscope which consists of 40-50-60 power clear vision adjustable microscope with hair lines spaced

6/1000ths (.152 mm) of an inch apart for accurate determination of groove width and minute examination of the side walls of the groove.

It is equipped with electric light bulb and reflector, both of which are adjustable, for focusing proper illumination at the exact point under examination.

More complete information may be secured from the *Universal Microphone Co.*, Inglewood, Calif.—COMMUNICATIONS.

AUDAX PICKUP

The Audax Model AT-12, a low-priced pickup that approximates the Compensated Microdyne performance, has been introduced for records up to 12 inches. This new pickup is said to feature offset head, response to over 6,000 cycles, new needle guide, new non-resonant arm, precision ball-bearings, 200-500 ohms or high impedance. Details of this and other Audax

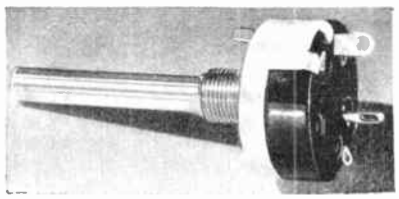
models may be secured from *Audak Company*, 500 Fifth Ave., New York City.—COMMUNICATIONS.

PORTABLE RECORDER

Radiotone, Inc., manufacturers of home and professional recording equipment, announce a new model portable recorder, the HR-16. This machine makes up to the 16" size record and includes all of the following features: dual speed, 33⅓ or 78 rpm, changable instantaneously; outside-in or inside-out recording at the flick of a finger; built-in radio tuner covering the broadcast band 550 to 1600 kc. May also be used as a public-address system. For further information write *Radiotone, Inc.*, 7356 Melrose Ave., Hollywood, Cal.—COMMUNICATIONS.

ROTARY POWER SWITCH

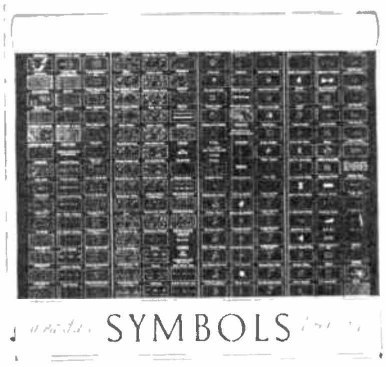
The convenience and compactness of the rotary type power switch are now available to manufacturers and builders of radio and electrical equipment. Much the same in general appearance to the usual midget potentiometer, the rotary switch operates on an arc of only 30 degrees. Fully enclosed. Dimensions: 1-3/32" dia. by 9/16" deep; locking projection on a 17/32" radius; ⅜ by ⅜" bushing; ¼" dia. shaft extending 1½" beyond bushing. Other bushing and shaft lengths can be had. Switch is available in s-p-s-t, d-p-s-t, s-p-d-t, s-p with bushing terminal, s-p reverse operation, and 4-wire s-t. Rated at 1 a 250 v, 3 a 125 v, and 10 a 12 v. Under-



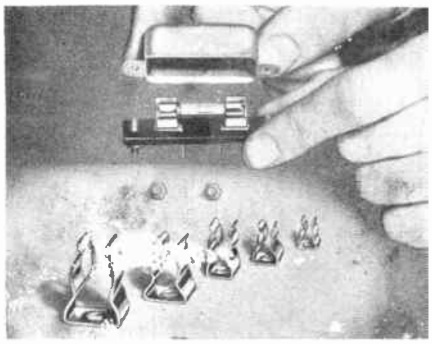
writers Laboratories Inspection label. *Clarostat Mfg. Co., Inc.*, 285-7 N. 6 St., Brooklyn, N. Y.—COMMUNICATIONS.

SYMBOL CHART

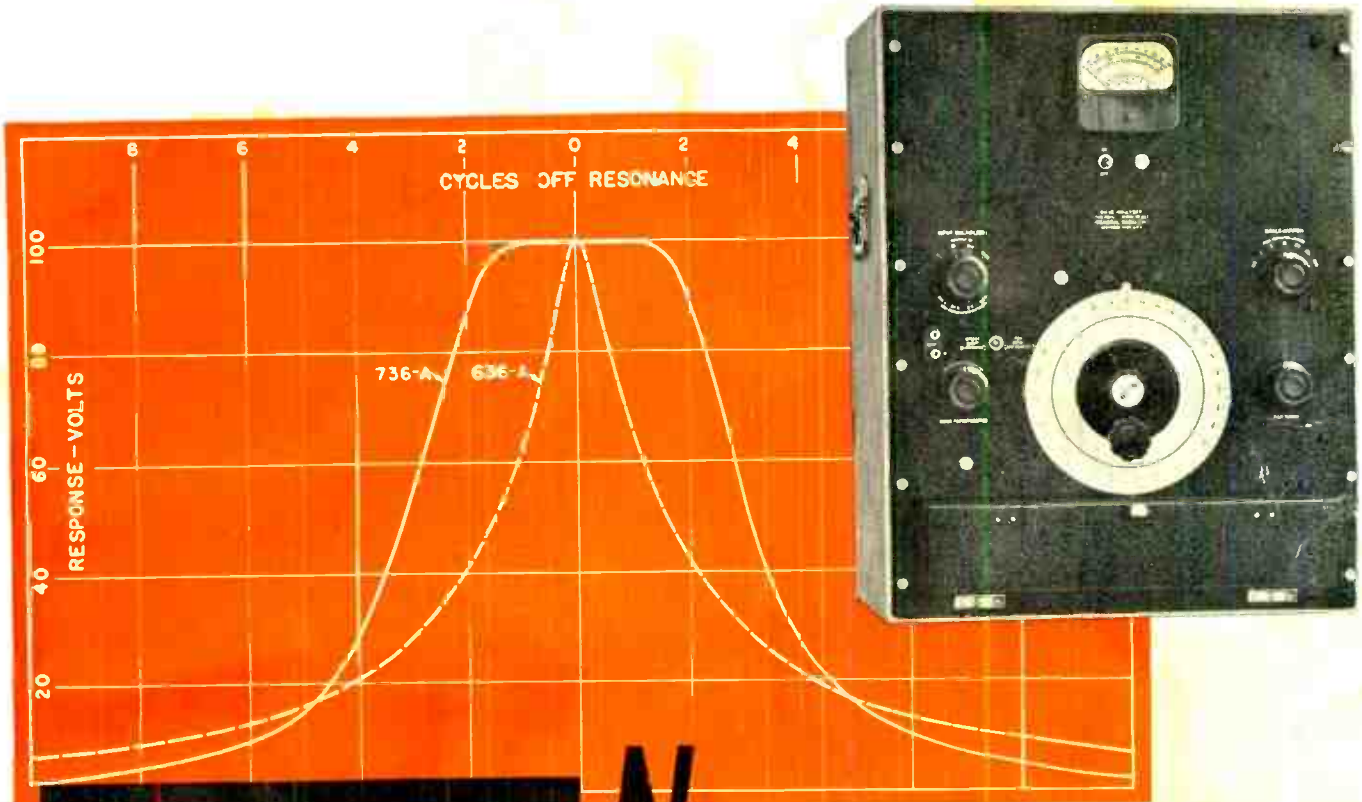
The Frederick Post Company has compiled on a single chart 249 engineering



drafting symbols which were selected, with the co-operation of architectural and engineering societies and groups, from more than twice that number. These symbols are reproduced on a single chart 26"x35" suitable for wall hanging. These charts are available without charge from *The Frederick Post Company*, P O Box 803, Chicago.—COMMUNICATIONS.



Advertising Index



Hermetically sealed 3 electrode quartz crystal in rubber cushioned, cast mounting frame

Illuminated linear meter with auxiliary db scale

Direct reading from zero to 16,000 cycles

Low-impedance, stable, aperiodic amplifier of moisture proof construction

NEW WAVE ANALYZER

IMPROVED SELECTIVITY, INCREASED STABILITY, EASIER OPERATION

With the new General Radio Type 736-A Wave Analyzer you can determine with speed, accuracy and simplicity the harmonic distortion in audio-frequency equipment, broadcast receivers, transmitters, public address equipment, telephone lines and associated equipment, oscillators amplifiers and vacuum-tube circuits of all types.

The new analyzer . . . a development of the widely used Type 636-A instrument introduced several years ago . . . has these mechanical and electrical improvements which contribute to its over-all utility in analyses of complex waveforms not easily made in any other manner:

- CRITICAL TUNING UNNECESSARY—flat-top tuning characteristic 4 cycles wide (see curve above)
- IMPROVED SELECTIVITY—new 3-crystal filter increases discrimination against unwanted voltage. Attenuation at 60 cycles from resonance is 75 db (0.02%)
- EASIER OPERATION—improved calibration circuit makes precise balancing unnecessary and speeds up measurements
- EXTENDED VOLTAGE RANGE—300 microvolts to 300 volts full-scale with 1 megohm input impedance
- INCREASED STABILITY—all components protected against effects of humidity. Oscillator and amplifier stability improved greatly
- A-C OPERATION—with hum voltage less than 50 μv
- NO EXTERNAL MAGNETIC PICK-UP—balanced modulator is fed by a phase-inverter tube instead of a transformer

Type 736-A Wave Analyzer $643.0

Write for Bulletin 344 for Complete Data

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CAMBRIDGE, MASSACHUSETTS

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PRECISION ELECTRICAL LABORATORY APPARATUS

You'll like the Efficient Versatility of this

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FEATURES OF 80-A

1 Low initial and installation costs. Easily and quickly installed.

2 All necessary facilities for two studios and transcription-announce booth.

3 Equalizing and switching for broadcasting and cueing remote lines.

4 Auditioning of studios, lines or transcriptions simultaneous with program transmission.

5 Talk-back to studios and remote lines with automatic speaker cut-off.

6 Complete emergency channel quickly connected by means of key switches.

7 Step-by-step ladder pad mixers.

8 Eight watt, high fidelity monitoring and audition system.

9 Simplified single studio design (Type 80-B) available at lower cost for individual control rooms.

10 Factory assembled, wired and tested. Guaranteed reliability.

11 Instrument's desk top is polished black bakelite finish. Chromium frame. Control turret and amplifier compartment are two-tone umber gray or black.

12 Illuminated VI and plate current meters.

80-A Desk with amplifier control compartment, doors opened showing easy accessibility of compactly installed amplifier units.

The new 80-A RCA Control Desk offers broadcasting stations a complete factory wired and tested assembly of speech input equipment for the efficient operation of 1, 2 or 3 studios. The desk is a combination of the equipment usually mounted in a rack and its associated operators' console. Full-sized components, separate standard amplifiers and double jack strips give this desk the same advantages of flexible speech input systems usually associated with rack type installations. With the 80-A desk you'll attain a maximum of flexibility and fidelity at a minimum of expense.

Note the many splendid features of this desk. If you wish further details write to the address below. No obligation, of course.

Use RCA Tubes in your station for quiet, reliable performance.

RCA

Broadcast Equipment

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